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CONTENTS

ARTICLES PAGE

Modifications Increasing Efficiency of Hand Compression Sprayers for Malaria Control.... Fred W. Knipe 187

The 1957 Status of Yellow Fever in the Americas.....Fred L. Soper 203

Primary Record of *Culiseta melanura* Biting Man in Nature..... R. O. Hayes and O. W. Doane, Jr. 216

Comparison of Four Sampling Methods for Measurement of *Culex tarsalis* Adult Populations.....R. O. Hayes, R. E. Bellamy, W. C. Reeves and M. J. Willis 218

Preparation of Thick Malarial Blood Smears by the Tapping Method.....G. J. Burton 228

Aedes sollicitans and *A. taeniorhynchus* Larval Emergence from Sod Samples..... C. M. Elmore, Jr., and R. W. Fay 230

A Simple Insectary Artificial Light Controller.....H. W. Fowler, Jr., W. P. Murdoch, H. R. Bullock, W. H. Parker and H. D. Baumgardner 234

PAPERS AND PROCEEDINGS OF ANNUAL MEETING—PART II

International Course in Malaria Eradication Techniques.....H. D. Pratt and D. R. Johnson 236

Maintenance Equipment Used on Maryland Salt Marshes, Including a New Ditcher..... E. E. Lynch 238

Observations on Three Species of *Chaoborus* Licht. (Diptera: Culicidae) at Churchill, Manitoba.....H. G. James and B. C. Smith 242

Reactions to Mosquito Bites.....A. Hudson, J. A. McKiel, A. S. West and T. K. R. Bourns 249

The 1956–1957 Status of *Aedes aegypti* in the United States..... G. R. Hayes, Jr. and M. E. Tinker 253

OPERATIONAL AND SCIENTIFIC NOTES..... 258

ASSOCIATION NEWS 259

NEWS AND NOTES..... 260

REVIEWS AND ABSTRACTS..... 264

BIBLIOGRAPHY 265

LIST OF ADVERTISERS..... XVII

ADVERTISING RATES 273

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MODIFICATIONS INCREASING EFFICIENCY OF HAND COMPRESSION SPRAYERS FOR MALARIA CONTROL [1]

FRED W. KNIPE [2]
The Rockefeller Foundation, New York, N. Y.

INTRODUCTION

Hand pressurized compression sprayers adaptable to residual spraying have undergone relatively extensive improvement since such spraying has become general. The demand by user agencies for improvement in performance, particularly with regard to ease and economy of operation, has stimulated continued efforts to meet more exacting specifications.

This specialized equipment, developed for a specific program, is now finding a market in the agricultural field as well. For instance, the pressure regulator, which is widely used on compression sprayers in malaria eradication programs, is being adopted as standard equipment by certain tea estates. This element assures a more even distribution of insecticides within the limits of the pressure for which it is preset. So far as is known it was first used on hand compression sprayers in India in 1942 (1, 2).

World Health Organization authorities, sitting as an Expert Committee on Equipment Development, from time to time have indicated the course to be followed in improving this type of sprayer. The Committee has sometimes made thought-provoking suggestions that resulted in modifications not previously mentioned by them. The present paper describes some of these improvements, which have been developed under the guidance of the author.

The standards established by the W.H.O. Committee must be closely followed. One of these specifies that the total weight of the apparatus may not exceed 12 pounds. Since nearly all present models of sprayers weigh very close to 12 pounds, it behooves the developing agency either to install something very light, or else to reduce weight in an existing element, in order to meet specifications. These are not always easy tasks.

During the past few years, various improvements in efficiency have been developed under the guidance of the author. Some of these improvements have made possible complete abandonment of certain elements and reduction of weight in others. Several of the newer elements are not yet in common use, and may not be incorporated commercially for several years because fabricators, for their own good reasons, are often loath to make changes in model design. A case in point again is the pressure regulator, which, so far as is known, was not installed on hand compression sprayers by any manufacturer until nearly ten years after its practical application was established.

It is the intention in this review to discuss the modifications proposed in terms of the reasons behind their development, the advantages and disadvantages which they provide, and their relation to the weight problem.

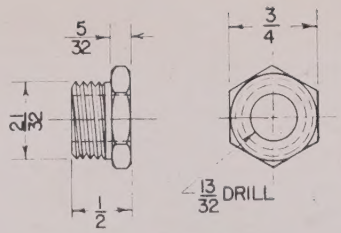
PROPOSED MODIFICATIONS

CLEAR PLASTIC TUBING

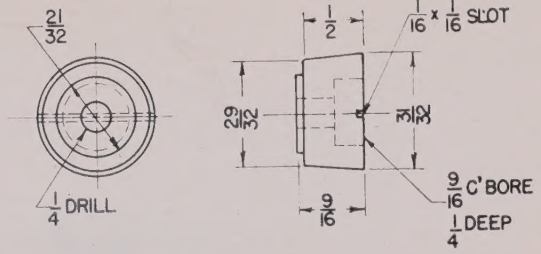
Plastic tubing, fabricated from polyethylene or polyvinyl chloride (P.V.C.),

[1] Developed during the interval 1953–1957, with particular reference to residual spraying.

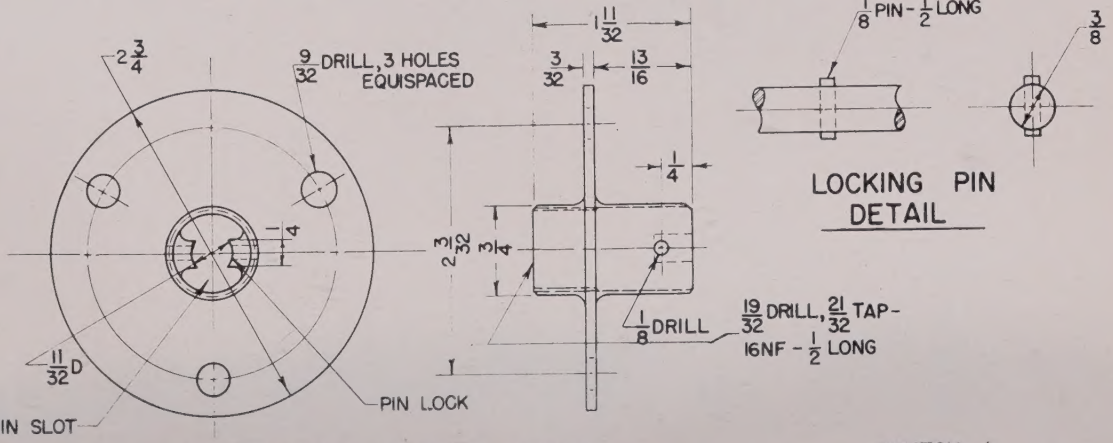
[2] Present address: 517 West Park Avenue, State College, Pennsylvania.



SPRING RETAINER BUSHING



PLASTIC SPACER



LOCKING PIN DETAIL

PLUNGER LOCKING DEVICE

SKETCH 1
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ROCKEFELLER FOUNDATION
FEB. 1958

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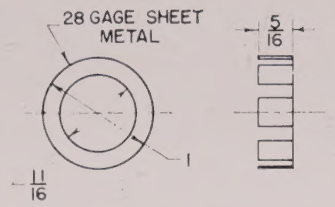
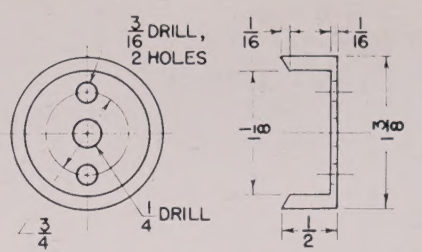
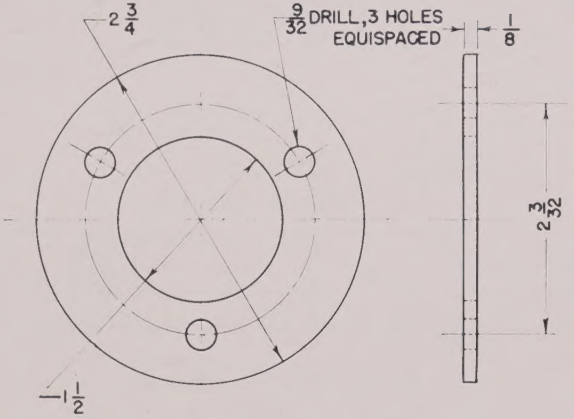
PENNSYLVANIA STATE UNIVERSITY



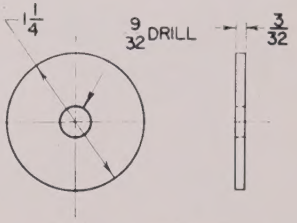
EXPANDING SPRING



CUP LEATHER



PLASTIC BUSHING



CUP LEATHER SUPPORT

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SKETCH 2
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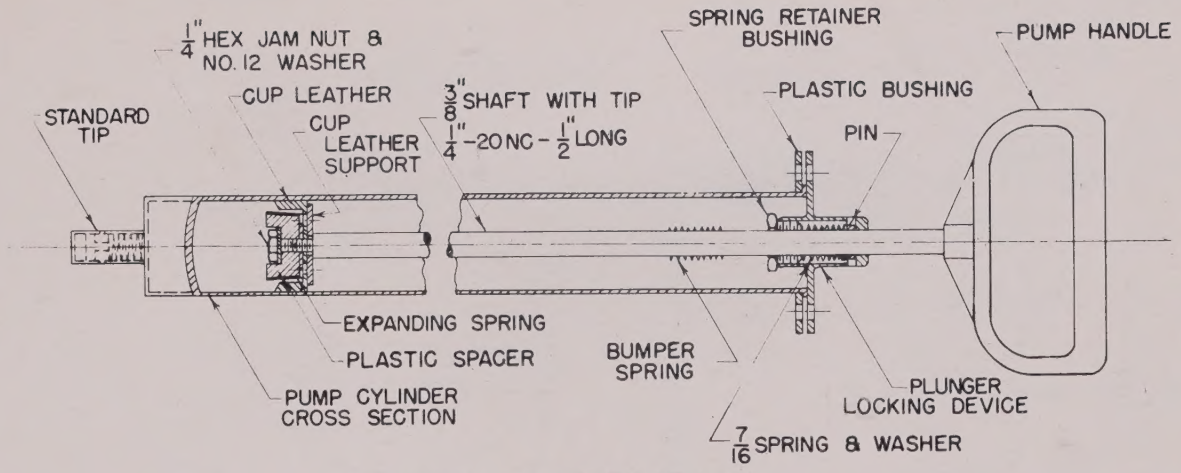
ROCKEFELLER FOUNDATION
FEB. 1958



PUMP ASSEMBLY

SKETCH 3
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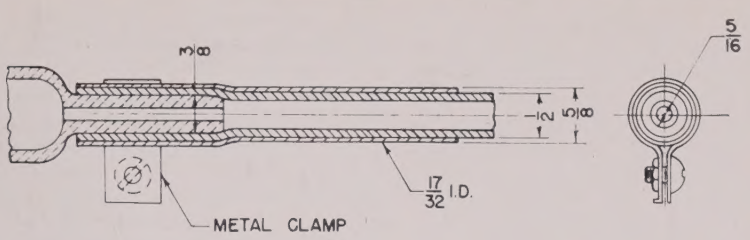
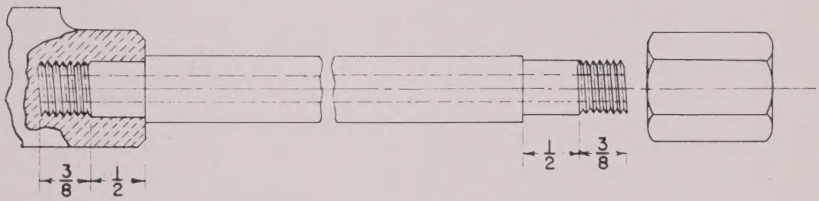


TUBING END REINFORCEMENT
(FLEXIBLE)



TUBING END REINFORCEMENT
(RIGID)

SKETCH 4
FRED W. KNIPE
ROCKEFELLER FOUNDATION
FEB. 1958

DRAWN BY W.W.MANN
PENNSYLVANIA STATE UNIVERSITY

has almost completely replaced rubber as the material of choice on malaria control equipment in India. It has been used in the field since 1953. The type is a clear transparent plastic, although it may be tinted slightly with any desired color. Opaque or opalescent tubing is considered less satisfactory, as will be explained later. So far as is known, plastic tubing was first used by the author on hand compression sprayers in Italy in 1946–47.

ADVANTAGES. 1. Low cost. The cost in India, where most of the trials upon which this report is based were made, is from 40 to 60 percent less than that for comparable rubber tubing.

2. Less weight. Plastic tubing weighs as much as 50 percent less than rubber tubing adequate for the same purpose.

3. Long life. Clear plastic tubing appears to have a longer life expectancy, under comparable working conditions, than locally procurable rubber tubing (in India), and has been found superior to rubber tubing on spraying equipment usually imported into India. In fact, during the past four years there has been practically no tube failure when plastics were used.

In this connection, it should be noted that opaque or opalescent types appear not to have the durability of the clear types. In local experience, opaque tubes have not withstood as high bursting pressures as clear tubing of the same wall thickness. The ordinary clear tube in use, 2.5 mm wall thickness, will withstand 170 to 200 p.s.i. bursting pressure.

4. Resistance to insecticides. At atmospheric temperatures, polyethylene and P.V.C. tubings are apparently not affected by insecticides used in malaria control formulations or by their solvents and diluents. In this respect the two materials appear to be considerably superior to locally procurable rubber tubing.

5. Ease in maintenance. Because the tubing is clear, the operator and the inspector can see the liquid passing through the tube and thus readily determine whether the tube has been properly cleaned.

DISADVANTAGES. 1. Plastic tubing of the desired types is sufficiently flexible at temperatures above 40° F. or 5° C. Below approximately this temperature, however, it tends to stiffen slightly, although it becomes flexible again when the temperature rises above 40° F. Since most residual spraying operations for malaria control take place at temperatures above 40° F., this disadvantage is of minor importance.

2. After long exposure to sunlight and weather, the tubing will slowly harden and may become slightly brittle. This point has caused no serious difficulty in five years of local operations and observations (in India and Sardinia). According to the fabricators, this disadvantage may be partially overcome by adding a quantity of tinting material to the plastic crystals at the time of manufacture. The hardening that takes place in some types of plastics when and as the plasticizer (softening material) "migrates" or evaporates is said to be retarded by the tinting.

TUBING END REINFORCEMENT

Tubing is subject to maximum wear and tear at the two points where it is attached: at the rigid element of the dip tube where it emerges from the tank, and at the fixed grip shank element of the cut-off valve (lance assembly). Rubber tubing often deteriorates in a period of weeks at these points. Plastic tubing wears considerably longer. Smaller diameters of plastics (1/4 to 3/16-inch internal diameter) may be easily reinforced at these points, with very small loss in flexibility, by placing a short length (6 to 8 inches) of greater diameter tubing over the full length tubing. Both tubing and reinforcing element are held in place by the usual hose clamp. Such reinforcing costs practically nothing and increases life expectancy almost indefinitely. (Sketch 4—Tubing End Reinforcement—Flexible.)

PLASTIC LANCE ASSEMBLIES

Complete lance assemblies have been fabricated from the plastic Tenite II

(C.A.B.) and have undergone successful field trials. The elements involved include: cut-off valve (with metal exceptions as noted); lance; goose neck; nozzle tip; and various male and female assembly couplings. The five elements within the cut-off valve assembly that are made from bronze or stainless steel are the fixed grip strainer, valve lever arm, valve fulcrum, valve pin, and valve assembly packing nut. Both clear and tinted types of Tenite II were investigated.

The first great advantage of a clear or tinted plastic lance assembly over metal types is ease of inspection and maintenance. One can see at a glance whether the assembly has been properly cleaned or where clogging occurs.

Another distinct advantage of an all-plastic over an ordinary bronze assembly is marked reduction in weight. The plastic assembly weighs from 12 to 16 ounces less than its all-metal counterpart. This is important when one considers that a lance assembly functions as a third class lever when in place in the operator's hand.

A third important advantage is that a plastic lance assembly costs from 40 to 60 percent less (1957) than a bronze model of similar construction.

Field trials with the plastic lance assembly have focused attention on several other noteworthy advantages. (1) The plastic tube, although considered rigid, is in reality somewhat flexible and does not remain distorted when bent (within the same limits) as does a metal lance. (2) It does not easily become distorted under a crushing load as does one made from metal.

A disadvantage, noted in the field trials, is that junction threads on the various elements, particularly on the cut-off valve, must be cut with more precision than is necessary with metal threads. Being slightly flexible, the plastic threads tend to strip or slide over each other. This fault may be overcome entirely by countersinking an unthreaded section of the connecting threaded male tubing into its female counterpart. (Sketch 4—Tubing End Reinforcement—Rigid.)

Plastic Nozzle Tips

Plastic nozzle tips have been under investigation for some time (3). Reasonably successful tips of this type that have been fabricated from Cellulose Acetate Butyrate (C.A.B.) and machine finished (discharge orifice), can now be procured.[3] Tips fabricated from P.V.C. are not yet available commercially. P.V.C. tips are superior to C.A.B. tips when durability is considered.

A plastic tip costs about Annas 4 ($0.05–1/4), as compared to Rs. 6 ($1.25) for a stainless steel tip. In other words, nearly 25 plastic tips can be purchased for the cost of one stainless steel tip. Development of plastic tips has been delayed by a seeming inability to mold or cut the tip orifice so that an acceptable discharge pattern will result. This difficulty has finally been overcome and plastic tip patterns are now as acceptable as locally machined (in India) stainless steel tips. Improvement is possible by developing close machining tolerances.

From the foregoing remarks relative to the development of plastics to a point where they may satisfactorily replace metallic lance assemblies and rubber hose, several points may be selected for emphasis. First, the price of plastic elements is approximately 50 percent lower than that of comparable metal parts. Second, plastic tips are very inexpensive compared to stainless steel tips (an important factor in a huge program such as is under way in India). Third, plastic hose and lance assemblies weigh considerably less than those made of rubber or metal. Fourth, plastic elements appear to be much more durable than their metal counterparts, particularly with respect to damage. Fifth, plastic hose and lance assemblies permit quick inspection and thus help to insure a clean working discharge line.

---

[3] From Dominion Plastics Co., Bombay, or from American Spring and Pressing Co.. Bombay (Madras), India.

SWINGING PLASTIC DIP TUBE

Through the dip tube, contents of the spray tank are conveyed to the external discharge line. Dip tubes usually have been made of bronze or brass. Sometimes these are permanently fastened in place inside the tank in order to prevent damage; in other instances the tube hangs suspended from the upper end, its rigidity being relied upon to hold it in position. In cases where a filter is attached to the intake end the tube cannot be held permanently in place, since the complete assembly (tube and strainer) must be regularly removed for cleaning.

Two disadvantages are inherent in metal tubes. First, complete discharge of the tank contents often does not take place because operators do not always carry the tank in the proper position; furthermore, the tube is frequently cut off well above the tank bottom and thus liquid below the tube end cannot be discharged. Secondly, the tube is heavy. It must be so in order to retain rigidity, resist distortion, and assure long life.

Both points are relatively minor and can be corrected easily by substituting a flexible plastic tube of the proper length. This tube slides over the bottom of the tank regardless of the position in which the tank is held—so long, of course, as it is held with the bottom downward—and thus insures complete tank discharge. Development practice of this procedure has been to use a few inches of rigid plastic tubing on the intake end of the dip tube in order to prevent "curling" of the flexible tubing.

When necessary, either the conventional metal intake strainer may be mounted onto the plastic tube or a plastic strainer may be substituted.

A "swinging" plastic dip tube weighs several ounces less than a metal tube, has a comparably long life, and is lower in both original and replacement cost. This is a point where a few ounces saved permits development of features which may add weight.

PUMP PLUNGER CUP MODIFICATION

The pump plunger cup consists of three elements: cup leather; cup leather spring that holds the cup in shape; and assembly nuts and washers that attach the cup leather to the plunger rod. As the name "cup" implies, this element does contain a hollow, cup-like section which is pointed toward the pressurized end of the assembly. When in operation, this cup should come to rest at the extremity of the pressure stroke in order to secure full pressurizing benefit from that stroke. Since tank pressurizing by hand is a tiring job, the apparatus should be so constructed as to reduce the total number of full plunger strokes required to attain full maximum pressure.

Practically all sprayer models fail in this respect in that they allow air under pressure to remain in the cup at the end of the pressure stroke. When 40 or more p.s.i. have been developed in the tank, the residual pressure in this small cup begins to assert itself. This point may be noted by the operator's releasing his grip at the end of the pressure stroke, whereupon the plunger will rebound upward, sometimes as much as half the length of the pump cylinder. Rebound is due to the pressure in the cup, provided the foot valve is not leaking (inexcusable under any circumstance). Pressure, once developed, remains in the cup and is wasted.

Repeated trials have proved that from five to eight full pumping strokes may be wasted in this way when pressurizing a tank to 50 p.s.i. with 50 full strokes of the plunger. Even five wasted strokes represent a ten percent loss in pumping efficiency.

This faulty design may easily be remedied by placing a heavy, slightly tapered, plastic gasket of a "bumper" type inside the leather cup supporting the spring. The gasket is held in place by a conventional nut and metal washer inserted in a recess cut into the plastic. (Sketch 3—Pump Assembly; Sketches 1 and 2—Detail Drawings.)

A flexible type of tough plastic such as P.V.C. should be used. The gasket is cut to a diameter sufficiently large to fit snugly inside the expanding spring. In thickness, it should be adjusted so that it lightly touches the floor of the pressure cylinder. At the end of the stroke this flexibility crushes into and fills the remaining space between the plastic and the supporting spring, thus forcing practically all compressed air into the main tank cylinder (Sketch 3).

This device has been successfully tested. It is cheap, easily replaceable, and adds practically no weight to the apparatus. Increased efficiency is worth the added bit of weight.

Even with modifications made to the plunger cup, a full stroke cannot be guaranteed unless the plunger locking device at the handle end of the rod functions properly. Many commercial sprayers are equipped with a locking device—to hold them in place after the pumping cycle—that does not readily permit a full downward stroke. When the male section of the locking device attached to the plunger rod strikes the fixed or female element attached to the tank top, it does not enter it, with the result that one-half inch or more of the downward stroke may be lost.

The fault may be entirely overcome by means of the locking device illustrated in Sketch 1 (Plunger Locking Device). This device has been widely and successfully used on certain models manufactured in European countries.

The principle of construction involves inserting a small hardened pin (the male element) into the plunger shaft in such manner that it will pass into the pump cylinder cap (the female element of the lock), where it strikes a washer-protected locking spring. The main purpose of this locking spring is to hold the two elements together at the end of the pumping operation. Locking takes place at the end of the pressure stroke by a slight turn of the plunger handle. This turn places the pin under the pin lock, as illustrated in the sketch. The pin lock shoulders block a comparatively small arc of the female element of the device. Entrance of the pin into the slots provided for it is practically guaranteed by the principle of construction, and a full downward plunger stroke is thus assured.

PRESSURE GAUGE PROTECTION BY MEANS OF A MODIFIED SYLPHON TUBE

The reasons why pressure gauges on malaria control equipment so often fail have been discussed in a previous paper (4).

A device to overcome most causes of failure has now been perfected. It consists of a short length of flexible plastic tubing properly attached to the pressure gauge. The added device has been designated a "Modified Sylphon Tube."

The plastic tubing of appropriate length (any convenient short length will do) is firmly attached to the shank extension of the gauge. Care must be taken that the outer diameter of the entire assembly is slightly less than the threaded gauge attachment shank in order to prevent damage when the gauge is attached to the tank. The tube must be permanently attached in a manner that prohibits any possibility of leakage. One way to achieve this is to use a threaded taper collar which compresses the tube firmly in place over the gauge shank attachment collar (Sketch 8). The internal diameter of the tube may vary according to the shank collar but depends somewhat on the size of the threaded gauge shank. The models developed and tried in the field were all attached to gauges with 1/8-inch shanks. The internal diameter of the tube was 5 mm and the external, 5.5 mm. Clear plastic tubing was used.

The opposite end of the tube—the end away from the gauge—is closed by means of a tapered bronze screw which passes into the tubing via a complementary bronze collar. This assembly must also be sufficiently small in diameter to pass through the gauge-to-tank attachment

port. In other words, it must be smaller than the gauge shank.

For the modified sylphon attachment to function properly, the sylphon tube and all closed elements of the pressure gauge, including the Bourdon tube, must be completely filled with a liquid of low viscosity. The liquid must have no corrosive effect either on the plastic or on the gauge elements. Water was successfully used on all trial models, both in the laboratory and in the field. If water is used, it must be boiled first in order to expel any air that may be present. Good quality hydraulic brake fluid appears well suited for this purpose.

Since the diameter of the tube opening is small, liquids do not enter readily. This difficulty is overcome by filling it with a hypodermic syringe having an unusually long needle. Special care must be exercised to force all air out of the Bourdon tube as well. Once completely filled with liquid and securely sealed, the apparatus can be attached to the sprayer tank in the normal manner. In order to facilitate further complete filling of the element, a short length of very small gauge flexible plastic tubing may be attached to the needle. This may be pushed around the U-bend in the metal tube, thereby permitting liquid to be pumped into the inner extremity of the Bourdon tube.

In action, as pressure is developed in the sprayer tank it is automatically transferred through the liquid in the modified sylphon to the pressure gauge. Since the modified sylphon is a self-contained unit, no insecticidal material can enter the pressure gauge, be deposited there, and thus interfere with operation.

This instrument was tested in the laboratory by repressurizing a sprayer tank, containing a standard DDT formulation, five hundred times. The very worst possible conditions were created in the tank insofar as wear on the instrument and possibility of contamination were concerned. There was no sign of failure, either within the gauge or within the tube.

In order to verify accuracy of the gauge reading, the instrument was repeatedly compared with readings of a gauge attached normally to the tank. No perceptible difference in reading could be observed.

Two models of the instrument were developed, one having an open-work bronze reinforcement case for the plastic tubing (Sketch 8), the other with no reinforcement. Both models performed satisfactorily; the opinion prevailed, however, that the unit which had no reinforcing case would be more successful in field operations. There is little or no possibility of this unit's becoming bent or broken through rough handling, and furthermore, because it is continuously "washed" by solution in the tank it cannot collect insecticide or other material that would interfere with operation.

A Trickle Valve that Registers Two Different Gauge Pressures

Most users of malaria control equipment now require a pressure regulator on their hand compression sprayers. By controlling pressure on the nozzle tip at a pre-set value, regardless of higher and continuously changing pressure within the tank, the regulator insures more uniform insecticide distribution, and consequently better residual spray application.

The question has always arisen of whether the pressure being delivered by the regulator varies during the discharge interval. Fairly frequent tests have been necessary to assure pressure uniformity. A means has now been developed whereby both tank pressure and nozzle tip pressure can be read directly from one gauge at approximately the same instant. This device has been named a "Trickle Valve." It is located within the pressure regulator.

The device is extremely simple in design and application and, since it weighs nothing, should cost almost nothing when applied to a new sprayer or to one already in use.

The trickle valve is made very simply. Within the pressure regulator are a valve and a valve seat; this valve regulates pressure through being opened a proper amount by spring pressure when the lance cut-off valve is opened. A properly functioning regulator valve always closes automatically when the cut-off valve is closed. To produce the desired effect of registering two different pressures at approximately the same instant, a very fine groove or channel is cut across the regulator valve seat with a fine three-cornered needle file. The groove must be just deep enough to permit the valve to leak slightly or "trickle" when it closes in response to the closure of the cut-off valve. The groove must not be very deep since the "trickle" must be low in volume (Sketch 6—Trickle Valve). Once the groove is cut and the valve reassembled, the apparatus is ready to function.

The next step is to attach the standard pressure gauge to or near the discharge (low pressure) orifice of the pressure regulator instead of in the conventional manner. It may be equipped with a modified sylphon tube, as described on page 195. Pressure is now generated in the tank cylinder and recorded as full pressure on the gauge. This happens because a small quantity of insecticide "trickles" past the regulator valve, thus generating full pressure at low volume in the discharge line.

As spraying proceeds, the cut-off valve is opened. Immediately pressure on the discharge line is adjusted by the regulator to the desired pre-set pressure and liquid flows at greatly increased volume; in fact, the trickle valve is by-passed. The nozzle tip pressure is now registered on the pressure gauge and can be adjusted as desired. When the cut-off valve is closed, after a lag of a second or two tank pressure is indicated; when the cut-off valve is opened to continue spraying, the nozzle tip pressure again is indicated on the gauge.

With such a device installed on a sprayer, the uncertainty regarding nozzle tip pressure is eliminated. The operator can always regulate tank pressure if some unforeseen variation takes place.

Quick Detachable (Bayonet Type) Attachment Discharge Line to Sprayer Tank

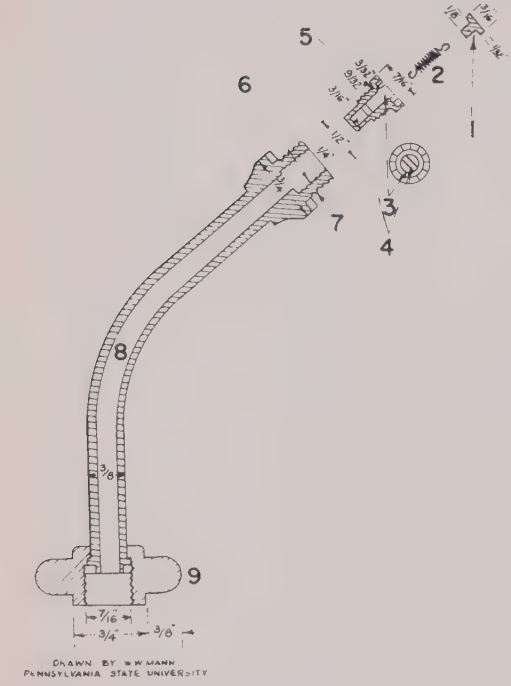
The type of quick detachable (Bayonet) attachment between discharge line and sprayer tank, often referred to as the "Q.D." attachment, has not been entirely satisfactory in the past. Attachment by this device was frequently more time-consuming than by the ordinary screw type coupling and furthermore the device was not always leakproof and repairs were not easily made.

A correctly functioning, leakproof, quickly detachable coupling that seldom requires repairs is nevertheless a desirable accessory. Quick detachment of the discharge line not only makes for ease in cleaning but also increases transportation facility and convenience in handling and general equipment servicing.

When in operational position, particularly on hand compression sprayers, the unit should function to increase efficiency of the spraying operation. It should be flexible, allowing the discharge line assembly to turn freely through 360 degrees at the point where male and female coupling elements join. This freedom of movement is an asset in increasing uniform spraying efficiency. The unit so constructed may be called "The Swinging Discharge Line."

It is mandatory that no leakage occur at any time during operation or when joining or separating the male and female elements. As already indicated, the female element of the assembly must be a self-closing, rapidly acting, leakproof valve. It should be attached to the tank-to-dip tube coupling through a standard pipe thread (1/4-inch), and by as short a coupling assembly as possible. The valve within the Q.D. assembly retains pressure inside the sprayer tank even though the discharge line assembly is detached. No pressure is required to open this valve, opening taking place automatically when the male element is attached.

The male element normally consists of a short (1/2-inch) bayonet type coupling

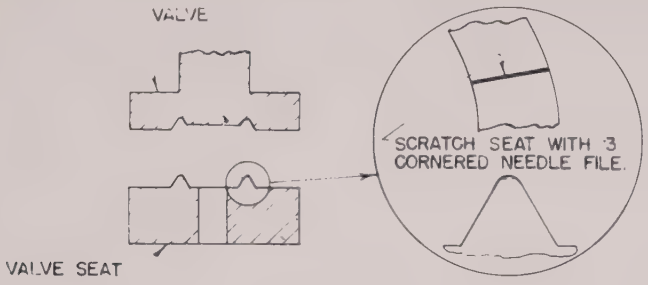


which is introduced into the female element by light hand pressure. The various designs for holding the male and female elements together usually consist of properly interlocking metal rings. Heavy duty, non-corrosive springs of various types hold locking elements in place during operation. Discharge from the male element takes place through a shaped hose shank into the plastic discharge line.

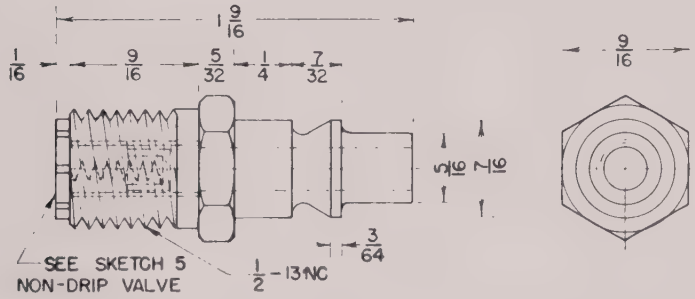
A commercial design for one type of Q.D. coupling [4] is shown in Sketch 7. This type of coupling is frequently used on high pressure compressed air lines but has been found equally satisfactory on the type of equipment under consideration. It is reasonably light in weight and has been hardened to withstand maximum field wear. The over-all length of the unit is approximately 2½ inches.

One essential modification is necessary to insure proper functioning of the unit, namely, the incorporation of a non-return or non-drip valve in the male element (Sketch 6—Q.D. Male Assembly). Unless this correction is made, insecticide within the discharge line will flow out through the detached open end of the element. The non-drip valve installed on experimental models was identical with the element used to prevent drip at the nozzle

[4] Manufactured by the ARO Equipment Corporation, Bryan, Ohio, USA, U. S. Patent No. 2,069,434.



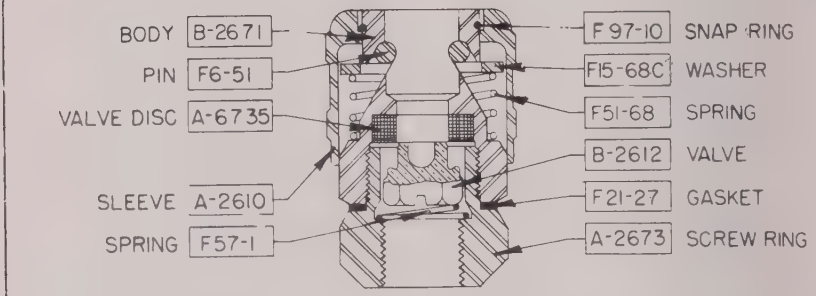
TRICKLE VALVE



Q. D. MALE ASSEMBLY

SKETCH 6
FRED W. KNIPE
ROCKEFELLER FOUNDATION
FEB. 1958

DRAWN BY W W MANN
PENNSYLVANIA STATE UNIVERSITY



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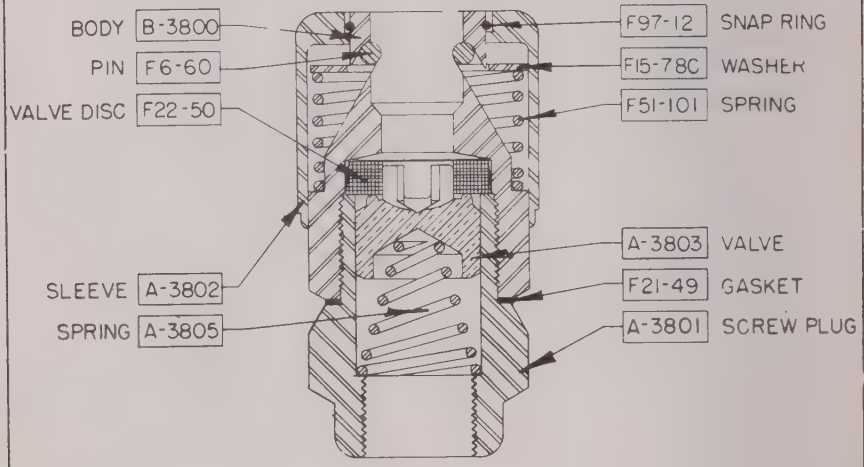

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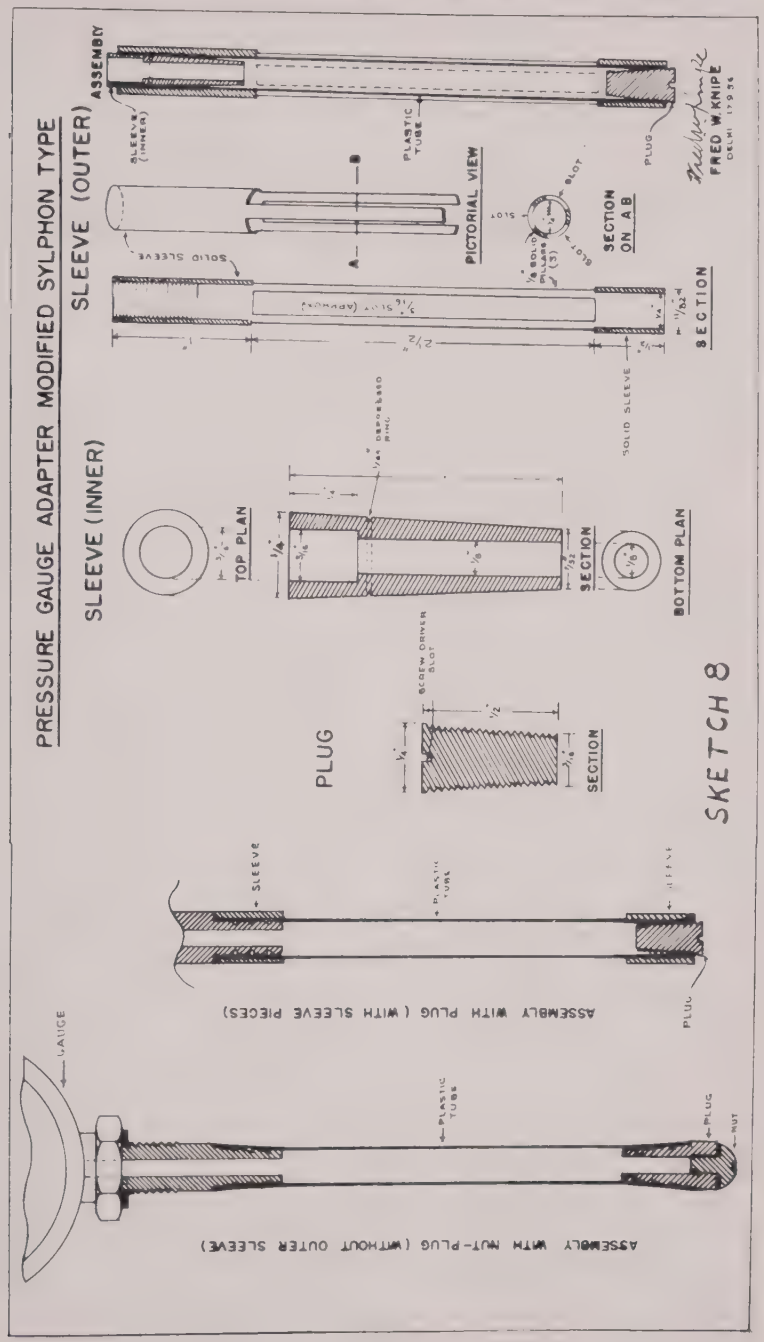
ENGINEERING DATA

1/4 " & 3/8" SPEED COUPLER
MODELS 210 & 310

SKETCH 7


PRESSURE GAUGE ADAPTER MODIFIED SYLPHON TYPE
SLEEVE (OUTER)
ASSEMBLY
SLEEVE (INNER)
PLASTIC TUBE
PLUG
PICTORIAL VIEW
SECTION ON A B
SECTION
SOLID SLEEVE
SLOT
TOP PLAN
BOTTOM PLAN
SCREW DRIVER SLOT
PLUG
SKETCH 8
FRED W. KNIPE
DELHI 1958
ASSEMBLY WITH PLUG (WITH SLEEVE PIECES)
ASSEMBLY WITH NUT-PLUG (WITHOUT OUTER SLEEVE)
GAUGE
NUT

tip when the spraying operation has been interrupted.

The entire Q.D. attachment shown in the illustration is simple in construction, leakproof, light in weight, and practically foolproof in operation. It is unusually easy to attach and detach, requiring only slight pressure with one hand to connect. The female element is detached by depressing a spring-activated sliding sleeve, after which the male element is lifted away from the attachment control.

At this point further reference may be made to the non-drip (or non-return) valve mentioned above.

Commercial fabricators of sprayers have been inclined to equip this valve with a spring requiring far too much pressure to be opened. The result is an ultimate loss in tank working pressure, particularly noticeable with equipment functioning at a nozzle tip pressure of 10 p.s.i. Instances have been encountered where 5 p.s.i. pressure were required to open the non-drip valve and consequently, a minimum of 15 p.s.i. working pressure was needed in the tank to assure normal operation. Such an arrangement defeats the purpose of a constant operational tip pressure of 10 p.s.i. —or any other pressure. A low operational pressure of 10 p.s.i. has been established to conserve pumping labor, and if accessories are added which individually or collectively increase operational pressure above 10 p.s.i. (or any other chosen operational pressure), then repressurizing must take place more frequently.

Spring tension on the non-drip valve should be maintained at the lowest level that assures closure of the valve. When the valve is in repose, the pressure within the discharge line should automatically return to atmospheric pressure on the discharge side of the cut-off valve. Positive closure of the non-drip valve located in the male element is thus assured, even though pressure may remain higher between the female element of the Q.D. valve and the cut-off valve. An excellent example of a non-drip valve and the mode of installation is illustrated in Sketch 5.[5]

SUMMARY

Descriptions are given of several component parts of hand pressurized compression sprayers that have been redesigned or modified to improve over-all discharge efficiency. Every effort has been made to lower the cost of any changed or added element and to reduce over-all weight below the requirements of the World Health Organization.

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1. KNIPE, FRED W. 1941. The use of solidified carbon dioxide in developing pressure for spray-killing adult mosquitoes in malaria control. Amer. Jour. Trop. Med. 21:671–679.

2. KNIPE, FRED W., and SITAPATHY, N. R. 1942. Notes on improvements made to equipment for spray-killing of adult mosquitoes. Amer. Jour. Trop. Med. 22:429–446.

3. KNIPE, FRED W. 1957. Nozzle tip erosion resistance tests. Bull. Wld. Hlth. Org. 16:211–217.

4. KNIPE, FRED W. 1957. Pressure regulators and gauges on hand-compression sprayers: Some causes of failure and suggestions for improvement. Bull. Wld. Hlth. Org. 16:217–225.

[5] Designed and manufactured by American Spring and Pressing Co., Bombay (Madras), India.

Editor's Note: Although the work described in Mr. Knipe's paper refers especially to conditions in India, its world-wide applicability is obvious. Since probably the majority of subscribers to *Mosquito News* utilize United States sources of supplies, the editor asked Mr. Knipe to furnish names of manufacturers and suppliers in this country where possible. In instances where no United States supplier's name is given, Mr. Knipe knows of no such source for the item mentioned. All the items are clearly described and figured, however, and if any readers know of possible sources of supply other than those given, it will be appreciated if that information is sent in to the editor so that it can be published.

THE 1957 STATUS OF YELLOW FEVER IN THE AMERICAS

FRED L. SOPER *

The professor of infectious diseases in a medical school, located in a city once the scene of a disastrous epidemic of yellow fever, inquired recently if the disease still exists in the Americas.

The statistics of the Pan American Sanitary Bureau list 77 cases officially reported during 1957, surely an insignificant number when related to the hundreds of millions of population of the Western Hemisphere. One might, then, be tempted to answer the query with a statement to the effect that yellow fever virus still exists in the Americas but that it is a public health problem of very minor importance. Such a reply would overlook these facts: these 77 cases come from seven countries, (Fig. 1), Bolivia, Brazil, Colombia, Guatemala, Panama, Peru and Venezuela; field studies have proven yellow fever virus to be present in British Honduras, where human cases were not observed during the year; and the range of the virus during 1957 from northwest to southeast has been over 3,500 miles.

A look at yellow fever in the Americas through the eyes of foreign health administrators might alter the indifference of the professor of infectious diseases.

The Committee on International Quarantine of WHO and the World Health Assembly, in meetings devoted to the preparation, adoption and modification of the International Sanitary Regulations, between 1949 and 1956, encountered greater difficulty in harmonizing the views of different countries, and groups of countries, on regulations for yellow fever than was encountered in the solution of all other differences.

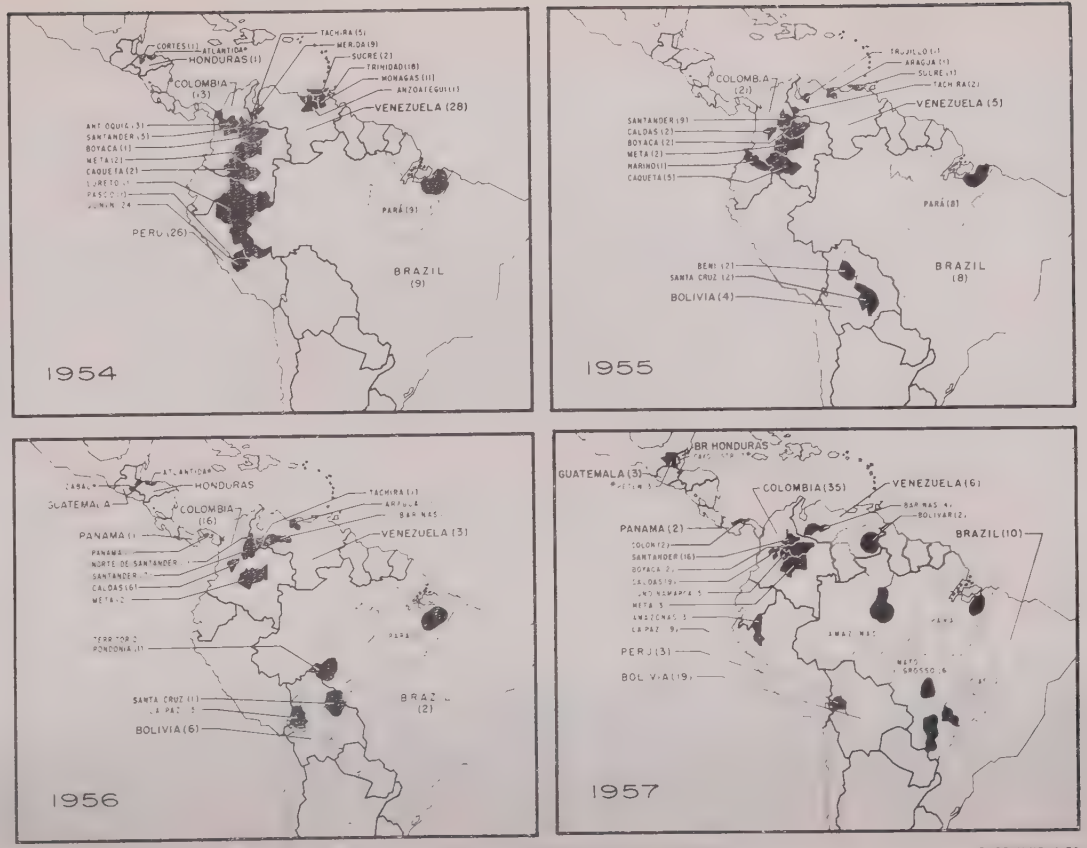
During early 1956, the WHO sponsored a visit of representatives of Egypt, Philippines, Indonesia, British Africa, Belgian Africa, India, France, and Iraq to several countries in America to get first hand impressions of yellow fever here. After one day at the Pan American Sanitary Bureau in Washington the group visited Cuba where there is an active campaign for the eradication of the *Aëdes aegypti* mosquito as a part of the continent-wide program to permanently prevent all urban yellow fever in the Americas. Then on to the then recently reactivated jungle fever zone of Honduras (Fig. 2) where it was learned that after an apparent silence of 15 months, yellow fever virus had not only persisted in Honduras but had moved northward into Guatemala (1).

In moving from Honduras to Guatemala yellow fever virus had left the range of its most widespread vector in the forests of South and Central America, *Haemagogus spegazzinii,* and had demonstrated its adaptability to *Haemagogus mesodentatus* (2) whose range extends well up into Mexico (Fig. 3).

In Costa Rica the group visited the San Juan de Dios Hospital where scores of cases of jungle yellow fever were under direct observation in 1951–52, and learned from those who had handled the cases that the clinical picture and high mortality of the jungle disease are in all ways similar to those of urban yellow fever.

In Panama the group learned the details of the cases of jungle yellow fever infected in 1948 only some ten miles from Panama's International Airport at Tocumen, and of the 1949 to 1951 march of the epizootic through Western Panama to the frontier with Costa Rica. It was noted that the five hospitalized cases of 1948 were diagnosed post-mortem two months after the first case and two weeks after the last one, and then only because the Santo Tomás Hospital has a full time pathologist. The group could not but wonder how many similar episodes may

* Director, Pan American Sanitary Bureau, Regional Office of the World Health Organization.



* DISCOVERY OF THE SPECIFIC LESIONS OF YELLOW FEVER IN THE LIVER OF VERTEBRATES OTHER THAN MAN

PASO WHO 4-58

FIG. 1.—Number of cases of yellow fever from countries of the Americas, by political divisions and years, 1954 to 1957.

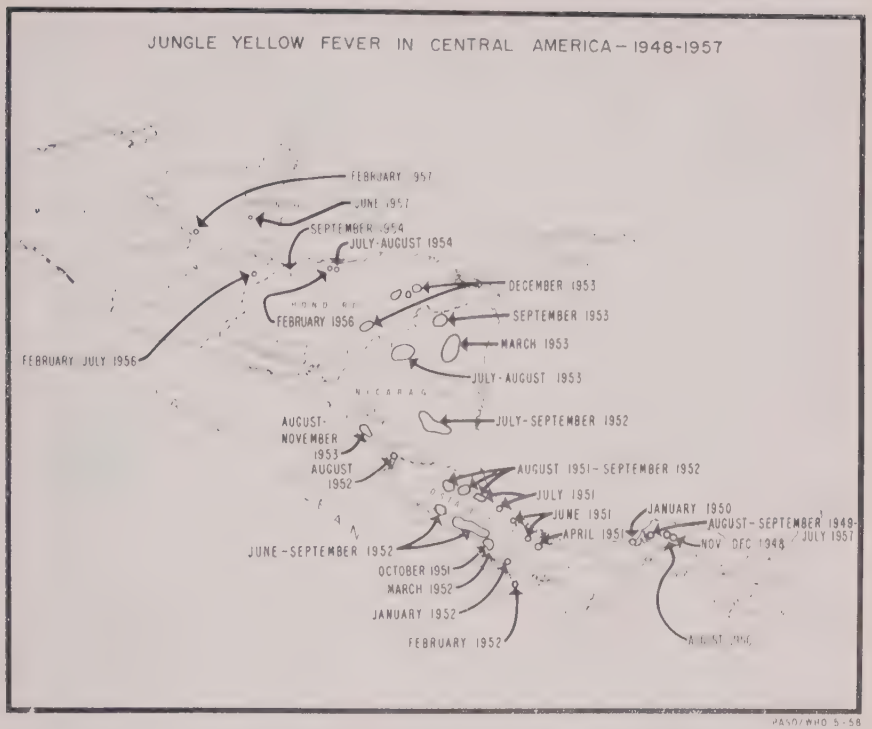


FIG. 2. Jungle yellow fever in Central America, 1948–1957.

have passed unnoted during the four decades yellow fever had been absent from the records of Panama and the Canal Zone. That this may have happened is suggested by the appearance in August 1956, of a case of yellow fever in the Santo Tomás Hospital (3), originating in the same jungle area which supplied the cases in 1948.

In Bogota, Colombia the visitors saw, at the Carlos Finlay Institute, the record of repeated and continuing incidence of yellow fever, year after year, and visited the yellow fever study area at San Vicente de Chucuri, Santander (Fig. 4), where in spite of repeated intensive vaccination campaigns, yellow fever cases have been confirmed in twelve of the last twenty-two years. San Vicente de Chucuri is apparently a permanent enzootic focus, in which, interestingly enough, monkeys are not present in numbers sufficient to maintain the virus unless there be some as yet unidentified reservoir or long-lived insect vector. Marsupials are suspected.

At Trinidad, B.W.I., the group learned of the early serendipitous discovery of yellow fever virus in jungle areas in April 1954, four decades after the last report of yellow fever from the Island, and of the urbanization of the jungle infection at Port-of-Spain some months later. Port-of-Spain was the first city in twelve years to report *aegypti*-transmitted yellow fever and the first maritime port in America to be infected in 25 years. Here, also, it was possible to see the intimate contact, through well paved roads, which exists between jungle and urban areas. The *Aëdes aegypti* mosquito has been widespread in human habitations along the rural highways, near the infected forests. In Trini-

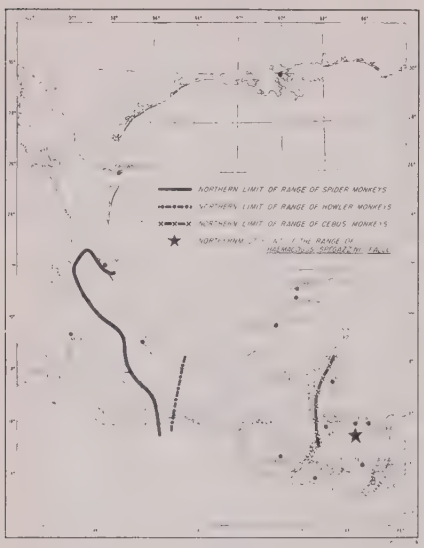

NORTHERN LIMIT OF RANGE OF SPIDER MONKEYS
NORTHERN LIMIT OF RANGE OF HOWLER MONKEYS
NORTHERN LIMIT OF RANGE OF CEBUS MONKEYS

FIG. 3. Northern limits of the range of monkeys in Central America.

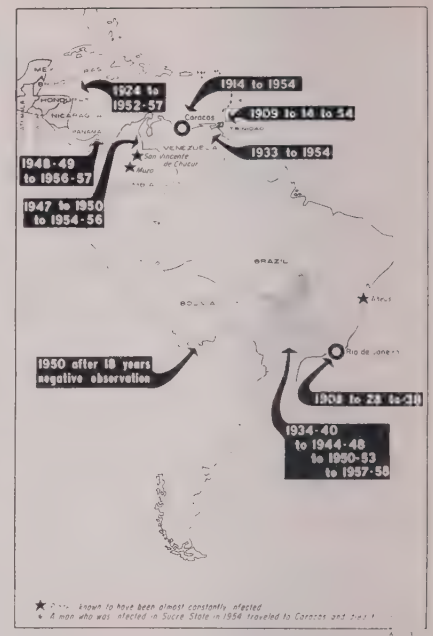


FIG. 4.—Intervals between the appearance of yellow fever in specific areas. (Courtesy American Journal of Tropical Medicine and Hygiene.)

dad, reports were also heard of positive neutralization tests carried out in 1953 of young teen-age Trinidadians born long after the last reported yellow fever, indicating the possibility of previous unrecognized outbreaks on the Island.

The visiting group could not fail to note that in spite of evidence indicating the presence of yellow fever virus in Trinidad during a twelve-month period and its spread throughout the Island, less than a score of cases were reported internationally. Obviously many more must have occurred.

At Belém, the gateway to the Amazon Valley, the group from overseas learned of the isolation of yellow fever virus, also serendipitous, from six febrile persons in 1954 not far from the city, when yellow fever was not known to be active in the area. The group also learned of repeated isolations of virus from naturally infected *Haemagogus* mosquitoes captured in 1955 in the Utinga forest at the edge of the city.

At Rio de Janeiro, the terminal point of its American tour, the group visited the National Yellow Fever Service and heard the story of the 1928–to–1931 struggle to free South Brazil of endemic yellow fever, (Fig. 5), which followed the reinfection of Brazil's beautiful capital, 20 years after Oswaldo Cruz' first victory over the disease in 1908 (Fig. 4).

As stated, the objective of the trip was to give the group a first hand opportunity to see the conditions under which yellow fever occurs in the Americas, in order to judge the threat which yellow fever here may be to other regions. The hope that the trip might result in an immediate lessening of the fear in the Orient of infection from America was not fulfilled. On the eve of his departure one member of the group declared that his anxiety regarding the possibility of the infection of Asia with yellow fever had doubled during the trip. This may well have been the reaction of the entire group, visiting

LOCALITIES KNOWN TO HAVE HAD CASES OF YELLOW FEVER FOLLOWING 1928 OUTBREAK IN RIO DE JANEIRO

FIG. 5.—Localities known to have had cases of yellow fever following the 1928–1929 outbreak in Rio de Janeiro.

the Americas in a year during which only 28 cases of yellow fever have been reported.

The indifference of the American professor of infectious diseases contrasted with the great concern of the health authorities of other regions emphasizes the need of an objective statement of the status of yellow fever in the Americas at the end of 1957.

With yellow fever, as with many other infectious diseases, long-term observations are needed for any objective appraisal of the situation, care being taken to make due allowance for any changes which may occur in basic epidemiological conditions.

During the century and a half previous to 1900 yellow fever occurred on both the Atlantic and Pacific coasts of North, Central and South America, and was very active in the Caribbean and Gulf areas. All countries of the Americas, not excepting even Canada, suffered incursions of yellow fever.

Following the confirmation in 1900 by the Reed Commission of Carlos Finlay's theory of the transmission of yellow fever by the *Aëdes aegypti* mosquito, dramatic results were obtained by the reduction of the breeding of this mosquito in endemic centers such as Havana, Panama, and Rio de Janeiro. There was a striking disappearance of the disease, not only from the cities where anti-mosquito measures were applied, but also from surrounding and tributary areas. And in 1915, on the basis of this experience, the International Health Board of the Rockefeller Foundation, under the leadership of Wickliffe Rose and General Gorgas, sponsored a program for the eradication of yellow fever from the Americas, (Fig. 6), based on the reduction of the *Aëdes aegypti* breeding in the endemic centers until the disease should spontaneously disappear. As a result of this program, the last focus of self-sustain-

FIG. 6.—Areas reported with yellow fever 1900 to 1931. (Courtesy The Jefferson Medical College of Philadelphia.)

ing man-*aegypti*-man yellow fever infection disappeared from the rural endemic area of northeast Brazil in 1934 (Fig. 7).

FIG. 7.—Areas reported with yellow fever 1932 to 1957. (Courtesy The Jefferson Medical College of Philadelphia.)

As the man-*aegypti*-man yellow fever was being eliminated, observation led to the discovery (4) in 1932 and succeeding years, of enzootic and epizootic yellow fever of the tropical forests of America. This was jungle yellow fever, the discovery of which gave a ready explanation of the source of virus for some previously unexplained *aegypti*-transmitted outbreaks in cities and towns isolated from any known source of infection: Rio de Janeiro, Brazil, in 1928; Socorro, Colombia 1929; Guasapati, Venezuela 1929; and Santa Cruz de la Sierra, Bolivia 1932 (5).

This discovery showed that the dream of eradicating yellow fever VIRUS was chimerical. The almost simultaneous perfection of methods for the eradication of the highly domesticated *Aëdes aegypti* led inevitably to a program for the eradication of this African invader from the Americas.

Even though conditions in the period between 1900, when the *aegypti*-transmission of yellow fever was confirmed, and 1931, when the last series of urban outbreaks ended, were quite different from those of the period following 1932, the year in which jungle yellow fever was confirmed and *aegypti*-eradication begun, it is instructive to compare the distribution of yellow fever in these two periods.

The yellow fever reported between 1900 and 1931 (Fig. 6), was distributed around the periphery of South America, around the Caribbean Sea and the Gulf of Mexico, and along the Pacific Coast of Mexico, and Central America. It was almost entirely urban yellow fever although the contemporaneous description of the Trinidad outbreak of 1914 clearly identifies that episode as jungle yellow fever. The reports for this early period are almost entirely of outbreaks diagnosed clinically and epidemiologically, whereas the reports for the later period 1932 to 1955 (Fig. 7), have come in large part as the result of routine viscerotomy and the histopathological confirmation of unsuspected cases. This is true even of the few cases of *Aëdes aegypti* transmitted yellow fever which have been reported. Yellow fever has been found widely distributed in the interior of the continent and even when reported close to the coast has only in one instance (Port-of-Spain 1954) infected any international port. The *aegypti*-transmitted yellow fever reported during this period was of two types: endemic rural yellow fever; and isolated urban outbreaks occurring very close, and secondary, to known infected jungle districts. The rural endemic yellow fever of northeast Brazil was terminated in 1934 by extending anti-*aegypti* measures to large rural areas and has not recurred.

In the period from 1932 to 1955 a huge amount of epidemiological information about both urban and jungle yellow fever was collected and studied (6).

This period includes the last three years

(1932–1934) of endemic *aegypti*-transmitted yellow fever in northeast Brazil, and the period from 1935 to 1942 when urbanization of jungle virus occurred in 13 towns of Brazil, Paraguay, Bolivia and Colombia, in areas from which the *aegypti* mosquito has since been eradicated.

In order to bring the yellow fever situation of recent years into clearer focus, the distribution of the 1606 cases of yellow fever reported during the decade 1948–1957 have been brought together in Table 1 (Fig. 8). During this ten-year period, yellow fever occurred from Guatemala on the north to Argentina on the south and filled in many previous blank spots in the map of jungle yellow fever. The human cases were confirmed in 14 countries—Guatemala, Honduras, Nicaragua, Costa Rica, Panama, Colombia, Venezuela, British Guiana, Trinidad, Ecuador, Peru, Bolivia, Brazil and Argentina—without the occurrence of any *aegypti*-transmitted outbreaks! Brazil, Colombia and Bolivia reported cases in each of the ten years. In addition yellow fever in monkeys was confirmed in British Honduras, Venezuela in nine years and Peru in seven. Ecuador reported cases in the Amazon Valley in 1949 and on the Pacific slope in 1951. This is the first report of jungle yellow fever west of the Andes in Ecuador and the first yellow fever on the Pacific slope of South America to be reported since 1921.

In 1950 yellow fever extended much farther south in Bolivia than it had been found during 18 years of observation. In Brazil, the Southern States of Mato Grosso, Goias, Minas Gerais, São Paulo and Parana were invaded from the Amazon Basin, 1950 to 1953, for the third time since 1934. In late 1957 deaths in Mato Grosso and Goias indicated that a fourth epizootic wave was beginning.

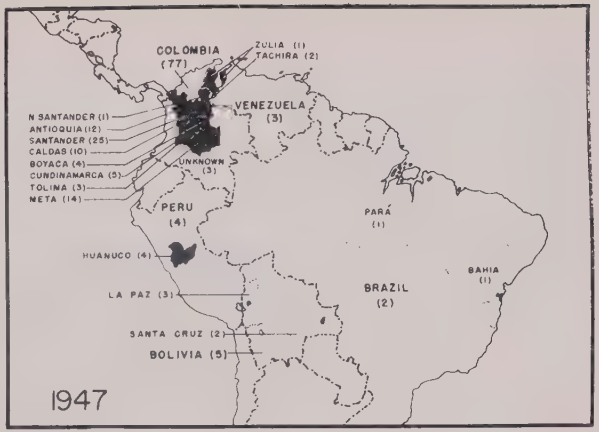
In 1954, northeastern Venezuela, after apparent freedom from yellow fever for twenty years, was shown to be infected. This area was probably the source of virus for the outbreak of the same year in Trinidad, already referred to, and is also notable as originating the first infectious case of yellow fever known to travel by air from the jungle to a distant *aegypti*-infested urban center—Sucre State to Caracas. In 1955 and again in 1956, jungle yellow fever was reported in the State of Aragua in north central Venezuela, far

TABLE 1.—Reported Cases of Yellow Fever in the Americas, 1948–1957

Area	1948	1949	1950	1951	1952	1953	1954	1955	1956	1957	Total
Total	54	174	391	312	341	89	97*	42	28	78	1606*
Argentina **	1	–	–	–	–	–	–	–	–	–	1
Bolivia	30	156	354	3	1	18	2	7	6	19	596
Brazil **	3	6	4	50	221	39	9	8	2	10	352
British Guiana **	1	–	–	–	–	–	–	–	–	–	1
British Honduras	–	–	–	–	–	–	–	–	–	***	–
Colombia **	12	3	12	26	16	11	12	22	16	35	165
Costa Rica	–	–	–	180	93	5	–	–	–	–	278
Ecuador	–	1	–	42	–	–	–	–	–	–	43
Guatemala	–	–	–	–	–	–	–	–	***	3	3
Honduras **	–	–	–	–	–	–	1	–	***	–	1
Nicaragua **	–	–	–	–	7	8	–	–	–	–	15
Panama	5	4	2	3	1	–	–	–	1	2	18
Peru	1	4	16	4	1	–	26	–	–	3	55
Trinidad and Tobago **	–	–	–	–	–	–	18*	–	–	–	18*
Venezuela **	1	–	3	4	1	8	29	5	3	6	60

* Jungle yellow fever, with the exception of 3 cases in Trinidad in 1954.
** All cases with laboratory confirmation.
*** Evidence of activity of the virus of yellow fever in howler monkeys (*Alouatta sp.*)

ZULIA (4)
TRUJILLO (3)
TACHIRA (4)
ANTIOQUIA (1)
SANTANDER (16)
VENEZUELA (11)
COLOMBIA (19)
CAQUETA (2)
PARÁ (1)
SAN MARTIN (3)
PERU (3)
BRAZIL (1)
LA PAZ (5)
SANTA CRUZ (14)
BOLIVIA (19)
1946


COLOMBIA (77)
ZULIA (1)
TACHIRA (2)
VENEZUELA (3)
N SANTANDER (1)
ANTIOQUIA (12)
SANTANDER (25)
CALDAS (10)
BOYACA (4)
CUNDINAMARCA (5)
TOLIMA (3)
META (14)
UNKNOWN (3)
PERU (4)
PARÁ (1)
HUANUCO (4)
BAHIA (1)
LA PAZ (3)
BRAZIL (2)
SANTA CRUZ (2)
BOLIVIA (5)
1947

PANAMA (5)
PROV. PANAMÁ (2)
CLINICAL CASES (3)
VENEZUELA (1)
BOLIVAR (1)
BRITISH GUIANA (1)
BERBICE (1)
ANTIOQUIA (1)
SANTANDER (1)
CALDAS (1)
BOYACA (2)
CUNDINAMARCA (7)
COLOMBIA (12)
SAN MARTIN (1)
PANDO (1)
PERU (1)
BOLIVIA (30)
BRAZIL (3)
BAHIA (2)
SANTA CRUZ (29)
1948
MISIONES (1)
ARGENTINA (1)
RIO GRANDE DO SUL (1)

PANAMA (3)
COLON (3)
ANTIOQUIA (2)
BOYACA (1)
COLOMBIA (3)
NAPO-PASTAZA (1)
ECUADOR (1)
PERU (4)
AMAZONAS (1)
PARÁ (3)
SAN MARTIN (1)
ACRE (2)
CUZCO (3)
BRAZIL (6)
BENI (1)
SANTA CRUZ (93)
BOLIVIA (94)
1949

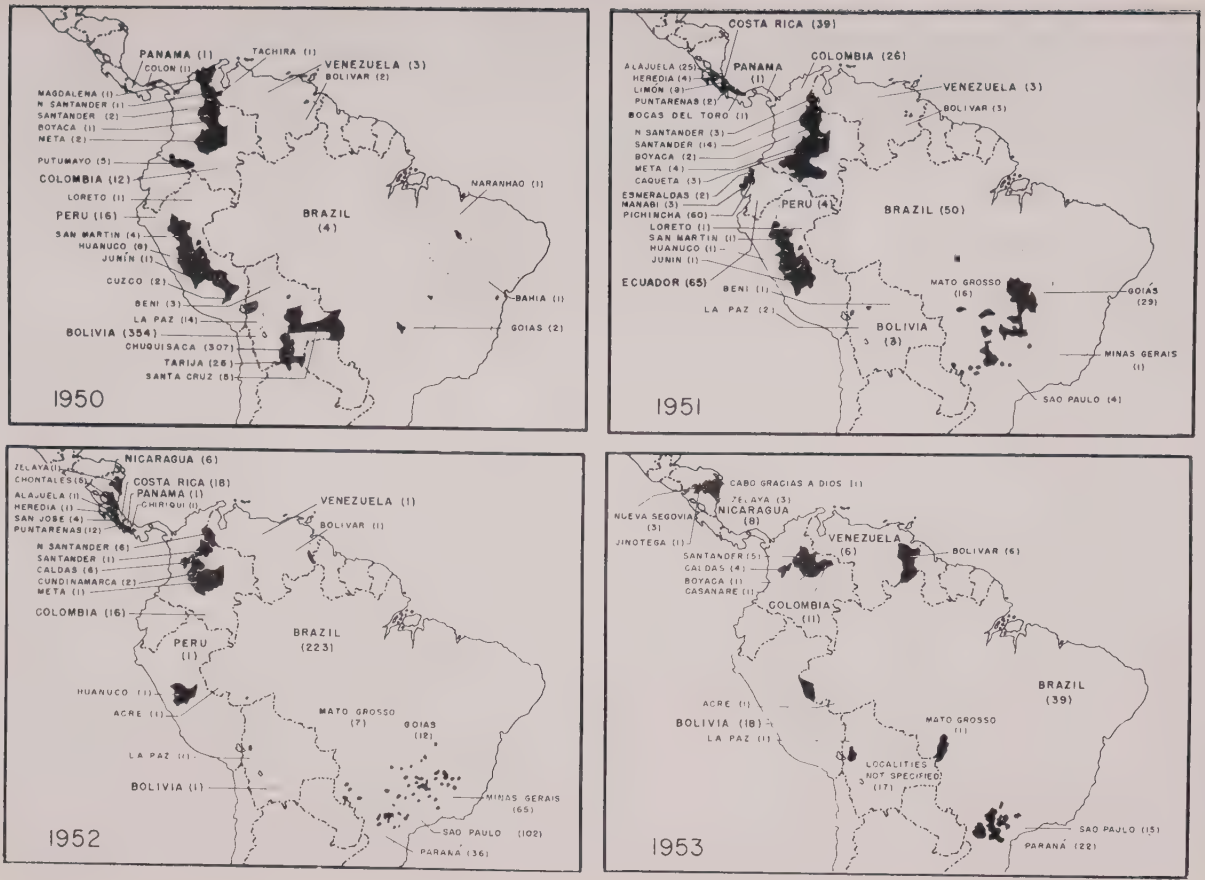


FIG. 8.—Number of cases of jungle yellow fever from countries of the Americas, by political divisions and by years, 1946–1953. (Courtesy American Journal of Tropical Medicine and Hygiene.)

from any previous reported focus of infection and only some 50 miles from the Capital.

In Panama, as already noted, yellow fever appeared in 1948 as a jungle infection east of the Canal, spread during the next five years across the Canal and up the Isthmus to Costa Rica and Nicaragua (7).

The events of the next three years, 1954, 1955, 1956, (Fig. 1), were to show that jungle yellow fever had not yet exhausted its ability to surprise the epidemiologists.

In Central America, in 1954, (Fig. 2), the enzootic which had previously been traced easily in Costa Rica and Nicaragua by the finding of sick and dead monkeys, was followed with difficulty across Honduras to the Ulua Valley near the frontier with Guatemala.

During 1955, no yellow fever activity, either in man or in monkeys, was reported in Central America. Surprisingly, early in 1956, activity among monkeys was reported in Honduras, in the same area where the activity had ceased 15 months before (1). Simultaneously, yellow fever among monkeys was observed across the border in Guatemala indicating progression of the epizootic wave. The year 1956 was one of considerable yellow fever activity in monkeys in Guatemala, without the occurrence of reported human cases. The activity in monkeys continued in 1957 in Guatemala and British Honduras; though human cases were confirmed in Guatemala.

The recurrence in Panama of jungle yellow fever in 1956 (3) and 1957 in the same districts where cases occurred in 1948, and the present epizootic wave, which has now reached Guatemala, when taken together raise the question of whether a second wave may follow the preceding one so soon in Central America where the susceptible monkey population was greatly reduced by mortality from yellow fever just a few years ago.

In Brazil, the 1950–53 outbreak in the Southern States stopped unexpectedly. Apparently drought conditions curtailed this epizootic before it completed its sweep through the forests of southern Brazil, practically all of which were invaded during the 1934 to 1940 epizootic. The only cases reported in Brazil during 1954 were found through routine virus isolations in an otherwise silent area near Belém at the mouth of the Amazon. In 1955 likewise yellow fever reported from Brazil was limited to this same area. In 1956 and 1957 there were a few scattered cases in the Amazon Valley.

The cumulative reports of yellow fever since 1932 and the unfolding picture of yellow fever since 1946, reveal clearly the absolute necessity of continuous observation and study if any appreciation, even approximate, of the sweep of epizootic cycles is to be obtained, for some of these cycles require a decade or longer for completion.

Even the 25-year period has been too short (Fig. 7), to give the whole picture of jungle fever in the Americas. This is due to the relatively long intervals which have occurred in certain areas between epizootic waves, as well as to the failure to recognize and report many, if not almost all, of the resultant human cases. The progress of a wave depends upon at least three coincident factors: the introduction of the virus; the existence of an adequate population of susceptible vertebrates; and weather suitable to multiplication and maintenance of adequate numbers of mosquito vectors. The study of the intervals between the appearance of yellow fever in specific areas indicates that yellow fever persists almost constantly in certain small areas, returns repeatedly after short periods of freedom in other areas, and recurs only after long and irregular absences in yet others.

Rio de Janeiro, already referred to as having been reinfected by jungle yellow fever virus in 1928, twenty years after the city had been freed of endemic yellow fever by Oswaldo Cruz, was again bombarded by jungle virus in a number of known infectious cases coming into the city from nearby infected areas in 1938.

During the past 19 years jungle yellow fever has not been observed in areas close to Rio nor have recognized cases appeared from further afield. Other areas have reported the recurrence of yellow fever after intervals of two or three years up to ten, twenty and even forty years.

This discussion of the status of yellow fever in 1957 has been largely limited to the official reports of the distribution of jungle yellow fever.

Since endemic *aegypti*-transmitted yellow fever no longer exists in the Americas, the problem of yellow fever during the past 20 years has been related to enzootic and epizootic yellow fever as a source of virus for jungle yellow fever cases, and to jungle yellow fever cases as a source of infection for *Aëdes aegypti*-infested towns.

The questions to be answered in assessing the yellow fever situation as a threat to man are: What is the importance of jungle yellow fever to rural populations of tropical America? What is the threat of the urbanization of jungle yellow fever virus in cities and towns in enzootic and epizootic areas? What is the international threat of jungle yellow fever?

Jungle yellow fever is clinically and pathologically indistinguishable from urban yellow fever and is just as dangerous to the person infected in or near the forest as to the city victim. The jungle disease is however generally limited to those living or working in or very close to the tropical forest or entering the forest for recreation or travel. Figure 9 shows the transmission cycle of jungle yellow fever in tropical America.

Where the homes are closely surrounded by forest in a permanently enzootic focus (Ilheus, Brazil) or where Indian tribes live in the forest, the people get infected with yellow fever even during the early years of life. Where road or lumber gangs enter the forest and where the forest is being cleared for agriculture the disease becomes almost occupational in its distribution and attacks a high percentage of young adult males at their most productive period (Espirito Santo, 1940; 108 deaths, 100 in males over 16) (San Vicente de Chucuri, Colombia 1936–1955; 55 deaths, 45 farmers, 7 women, 3 children).

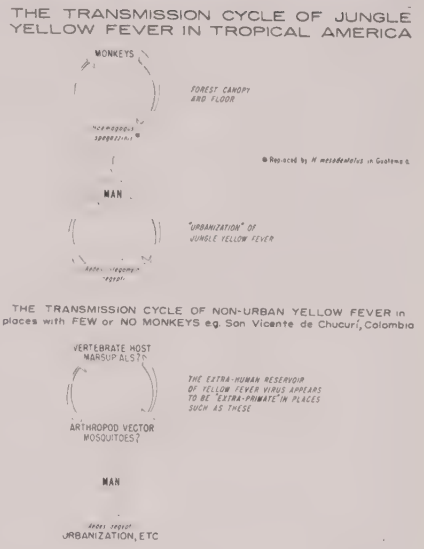

THE TRANSMISSION CYCLE OF JUNGLE YELLOW FEVER IN TROPICAL AMERICA
MONKEYS
FOREST CANOPY AND FLOOR
MAN
"URBANIZATION" OF JUNGLE YELLOW FEVER
THE TRANSMISSION CYCLE OF NON-URBAN YELLOW FEVER in places with FEW or NO MONKEYS eg. San Vicente de Chucuri, Colombia
VERTEBRATE HOST MARSUPIALS??
THE EXTRA-HUMAN RESERVOIR OF YELLOW FEVER VIRUS APPEARS TO BE "EXTRA-PRIMATE" IN PLACES SUCH AS THESE
ARTHROPOD VECTOR MOSQUITOES?
MAN
URBANIZATION, ETC

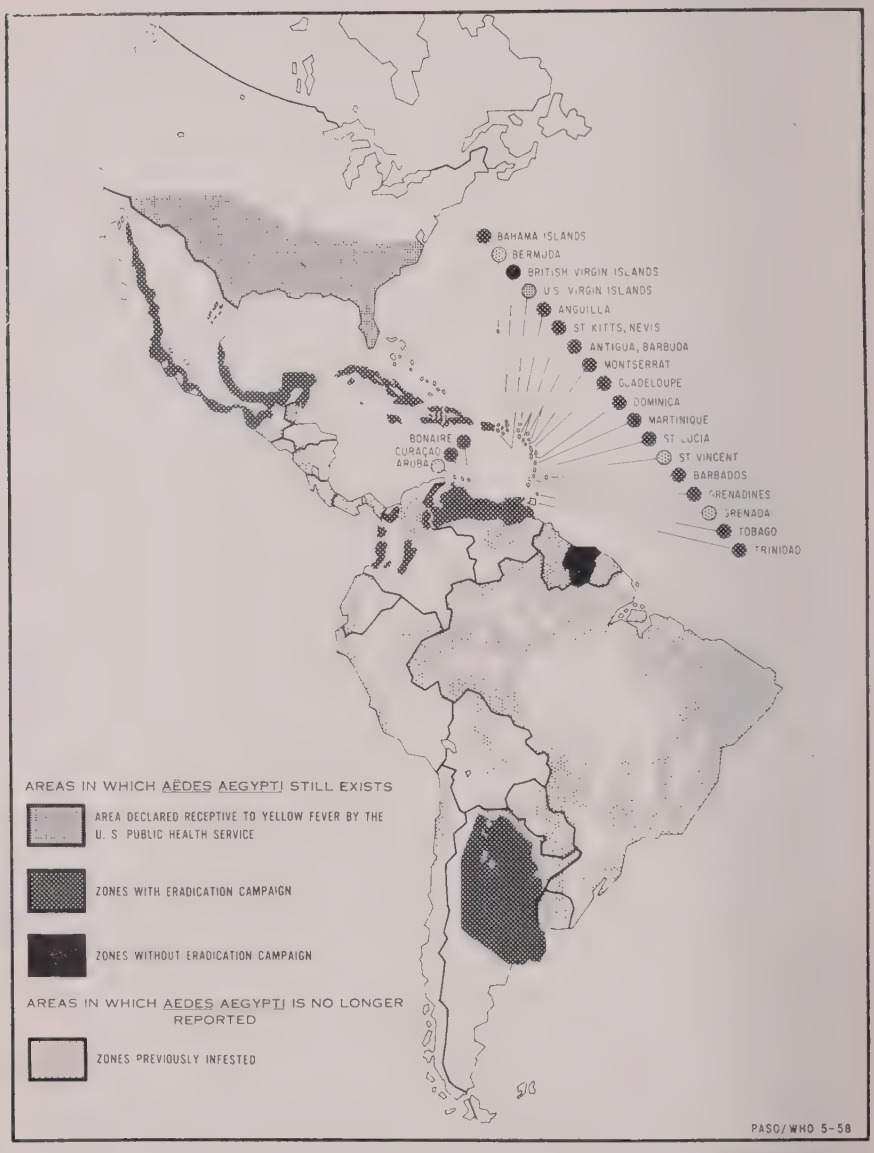
FIG. 9.—Diagrams of the transmission cycle of jungle yellow fever in tropical America. (Courtesy Boletin de la Oficina Sanitaria Panamericana.)

Where relatively light work, such as coffee picking, brings both women as well as men close to the forest, the disease tends to attack both men and women and even a considerable number of the children who accompany their parents to the fields. Thus it is clearly not necessary to chop down a tree to get yellow fever.

The development of a satisfactory yellow fever vaccine in 1936 greatly reduced the threat of jungle yellow fever, and has, in fact, practically eliminated it for those who are vaccinated.

The American nations are fortunate in having free access to vaccine, produced in the Oswaldo Cruz Institute, in Brazil, and in the Carlos Finlay Institute, in Colombia, in both with the collaboration of the Pan American Sanitary Bureau. Vaccination produces long lasting, probably permanent, immunity.

What is the threat of urbanization of



STATUS OF *AEDES AEGYPTI* ERADICATION CAMPAIGN IN THE WESTERN HEMISPHERE - 31 DECEMBER 1957

FIG. 10.—Status of the *Aedes aegypti* eradication campaign in the Western Hemisphere on December 31, 1957. (From the Annual Report for 1957 of the Director, Pan American Sanitary Bureau.)

jungle yellow fever virus near infected forests?

All observed urbanization of jungle yellow fever virus has occurred in towns relatively close to infected forests. The possibility of the introduction of yellow fever virus from forest to urban areas has been greatly reduced by the vaccination of large blocks of the populations living in jungle yellow fever areas: in Brazil, Colombia, Venezuela, Trinidad, Panama, Costa Rica, Nicaragua, Honduras, Guatemala and Mexico. However, vaccination is never complete, and absolute protection of towns can come only from the eradication of the *aegypti* mosquito.

The program for the eradication of the *Aëdes aegypti* mosquito from the Americas has progressed to the point (Fig. 10), where there is very little opportunity for cases from infected jungle areas to infect cities without undertaking an international trip. From Argentina to Guatemala, the *aegypti* mosquito has either been eradicated or is under heavy attack in all of the countries where jungle yellow fever has been reported in the past 25 years. To prevent reinfestation of those areas which have been, or are being, cleared of *Aëdes aegypti* it is essential that *aegypti* be eradicated also from the United States, Cuba, the Dominican Republic, Haiti, Puerto Rico, Jamaica, and the other Caribbean islands—where conditions for jungle yellow fever do not exist—as well as from Mexico where jungle yellow fever could occur, and which also has *Aëdes aegypti*.

What is the international threat of jungle yellow fever? In its extra-human reservoir the virus of yellow fever apparently moves through contiguous or nearly contiguous forest areas quite independently of man. The forest areas may all be in one large country like Brazil, or in half a dozen small ones like the Central American countries. The virus takes cognizance only of ecological boundaries, not of national ones (8).

It so happens that jungle yellow fever has never been observed to move internationally along human routes of travel. But in Venezuela in 1954 a man in the early—i.e. infectious—stage of jungle yellow fever traveled by plane from Sucre State to Caracas, a distance of several hundred miles. Facilities for both highway and air travel are constantly improving in the outlying areas of jungle yellow fever countries. This places those areas in closer contact, through man, with heavily used national and international routes of travel. *Aegypti*-infested countries, that could formerly rely on relative isolation from virus-infested jungles to protect them from yellow fever, may soon find that they are no longer effectively isolated.

Summary. Yellow fever virus is always present, with variable year-to-year distribution, throughout the tropical and subtropical forests of America from Mexico to Argentina.

In the decade 1948–1957 there was laboratory evidence of virus activity in 15 countries and territories. From four to eight countries were known to be involved each year. In three instances the presence of the virus was observed only in howler monkeys (*Alouatta sp.*). The countries involved were British Honduras, Guatemala and Honduras, in the years 1956 and 1957.

Jungle yellow fever is a serious threat to rural populations and is a permanent source of virus for the reinfection of such cities and towns, as may be infested with *Aëdes aegypti,* in the same country with infected forests and even of such cities and towns in other countries.

Maximum guarantees against yellow fever depend on the widespread vaccination of rural populations and on the eradication of the *Aëdes aegypti* mosquito from all of the Americas.

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PRIMARY RECORD OF *CULISETA MELANURA* BITING MAN IN NATURE

RICHARD O. HAYES [1] AND OSCAR W. DOANE, JR.[2]

The arthropod borne virus of eastern equine encephalitis (EEE) has been isolated from the mosquito *Culiseta melanura* (Coquillett) collected in Louisiana (1), Alabama (2), New Jersey (2, 3), and Massachusetts (4). The species has been considered a potential vector of the virus, since no other arthropod has been shown by virus isolation to be so closely associated with outbreaks of the disease throughout such a large geographic range. *C. melanura* is thought to be principally an avian feeder, and it has been postulated that it is involved in spreading the infection among the reservoir hosts—wild birds (5). A lack of evidence that it occasionally feeds on humans under natural conditions has precluded any specific hypothesis that this mosquito also spreads the infection to man. As recently as 1956 (6), it was noted that the feeding preferences and hosts of *C. melanura* were unknown. In the laboratory it has been induced to feed upon fowl, occasionally upon rabbits (7), upon mice (8), and once upon man (8). This report documents observations upon *C. melanura* biting man under natural conditions.[3]

On September 5, 1957 during a visit to a known *C. melanura* habitat in a cedar swamp, located in Raynham, Massachusetts, a female mosquito was seen to alight upon the dorsal forearm of one of us (R. O. H., who had previously been immunized with EEE vaccine). Since it appeared to be *C. melanura,* especial interest was taken in its subsequent activity. The mosquito landed approximately 1.5 hours before sunset and commenced exploratory probing with its proboscis among the hairs of the arm. The exploratory movements were quite slow, and 5 minutes elapsed before it appeared to have successfully penetrated the skin. At no time during the biting activity did it seem that the mouth parts were being deeply inserted into the skin. This behavior was similar to that previously described for feeding on chicks (7). The proboscis penetration was sufficiently deep, however, to provide a firm attachment to the host, and it was

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[3] This investigation is part of a joint study on eastern equine encephalitis by the Division of Communicable Disease, Massachusetts Department of Public Health, and the Communicable Disease Center, U. S. Public Health Service.

quite difficult to dislodge the mosquito during the capture. Biting was allowed to continue for 10 minutes, after which, the mosquito was collected in an aspirator tube. Before the tube containing the captured mosquito was removed from the host's arm, its circumference was marked on the skin with a ball point pen to delineate the region of the bite. Five minutes later, a slight swelling was noticed in the region, and within 10 minutes the area of noticeable reaction had increased to its maximum diameter of about 0.25 inch. The wheal remained visible for about 1 hour; such a reaction is typically produced on the host by the bite of most mosquito species. Neither during, nor after the biting activity was there a marked stinging or itching sensation.

The captured mosquito was taken to the laboratory, chloroformed, and identified as *C. melanura*.[4] Observation under a dissecting microscope revealed that there was no freshly imbibed blood visible, but that there was a small amount of undigested blood from a previous meal in the abdomen.

This biting record was obtained on a clear day having mild temperature. No special inducement to the mosquito was made, but it was not discouraged from biting. *C. melanura* adults had been collected from stump holes in this well shaded area on numerous occasions during the 3 previous months and have been repeatedly collected there since then without obtaining records of additional biting activity.

Apparently, under normal circumstances, this mosquito rarely feeds on humans. If *C. melanura* is the principal vector of human EEE infections, this behavior could account for the relatively small numbers of human cases reported (5), and the occasional infective feeding by the species on man could be expected to occur only after large numbers had fed on reservoir hosts circulating the virus in their blood. This combination of conditions would be necessarily dependent upon an assortment of variables, such as: climatic conditions, reservoir host epizootics, and the relative accessibility of human hosts; the infrequent occurrence of this combination could result in the characteristic interepidemic period between outbreaks of human cases of EEE.

[4] The authors express their appreciation to Dr. Alan Stone, U. S. National Museum, Washington, D. C. for his determination of the *Culiseta melanura* (Coquillett).

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COMPARISON OF FOUR SAMPLING METHODS FOR MEASUREMENT OF *CULEX TARSALIS* ADULT POPULATIONS[1]

R. O. HAYES,[2] R. E. BELLAMY,[3] W. C. REEVES[4] AND M. J. WILLIS[5]

INTRODUCTION

Accurate measurements of the abundance of adult mosquitoes are important to the epidemiologist who desires to relate the prevalence of vector species to the incidence of mosquito-borne diseases, and to mosquito control agencies for evaluation of their programs. The usual goal in measurement of mosquito abundance is to determine an effective *index of abundance* above which vector species may be expected to transmit disease or pestiferous species will be of sufficient nuisance to cause serious discomfort to man or domestic animals.

Because of the great diversity of habits of different species of mosquitoes, a method suitable for measuring populations of one species may be unsuitable for another. Currently, a reliable means is needed to measure abundance and fluctuations in numbers of *Culex tarsalis* in the western United States. This mosquito is now recognized as the primary vector of Western equine and St. Louis encephalitis viruses in this area, and extensive programs are being established for its control.

Several methods have been applied to measure the abundance of other important species of mosquitoes in temperate and tropical regions. These methods are generally based on periodic sampling of the general mosquito population by a standardized technique, and subsequent comparison of differences in the numbers collected or counted.

In the course of epidemiological investigations of the encephalitis viruses in Kern County, California, several methods for sampling populations of adult *C. tarsalis* showed promise in preliminary trials. In prior studies, population trends of this species had been obtained by periodic examination of populations in resting shelters or from samples collected by light traps. These methods had permitted the recognition of gross seasonal fluctuations in the abundance of the species; however, a comparative evaluation of several sampling methods was needed. Four promising methods of measuring populations of adult *C. tarsalis* were selected for comparison by concurrent testing in selected areas of Kern County.

The study was made in three field areas all within a 35-mile radius of Bakersfield and suitable for epidemiological investigations of the arthropod-borne virus encephalitides. Each area differed from the others in characteristic flora and fauna, but all had large mosquito populations, particularly of *C. tarsalis*. The specific study areas were: Jerry Slough, an area of intensively irrigated cropland largely surrounded by desert; Arkelo Olive Grove, a large olive grove in irrigated agricultural land; and Hart Park, a wooded recreational park along the Kern River.

[1] Contribution from the Technology Branch, Communicable Disease Center, Bureau of State Services, Public Health Service, U. S. Department of Health, Education and Welfare; and the School of Public Health, University of California, Berkeley, California. This investigation was supported in part by a research grant E 31 (C10) from the National Institute of Allergy and Infectious Diseases, U. S. Public Health Service. The authors are indebted to Mr. A. F. Geib and personnel of the Kern Mosquito Abatement District for assistance in field investigations and to Kern General Hospital for provision of laboratory facilities.

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Sampling Procedures

The four methods of sampling populations of adult mosquitoes selected for comparison were collection of specimens by:

1. Aspirator in "Natural Shelters."
2. Aspirator in "Artificial Shelters."
3. New Jersey and American Mosquito Light Traps.
4. Dry Ice (carbon dioxide) Baited Mosquito Traps.

1. Natural Shelters. Mosquitoes were known to come to rest during the day at all the natural stations selected, which included porches, garages, sheds, areas under bridges and houses, and hollows and irregularities at tree bases. In some instances the "station" was a specified portion of a shelter. Once a week all the mosquitoes were collected from each station, which were distributed as follows: 13 in Jerry Slough, 8 in Hart Park and 2 (each consisting of a row of 10 trees) in Arkelo Olive Grove.

2. Artificial Shelters. Cubical reinforced plywood boxes of one cubic foot capacity were enameled red inside and out, approximately the unit described by Goodwin (1942). The boxes were located on the ground at tree bases, a river bank, pastures, an alfalfa field, and even within natural shelters, such as garages and under buildings. In each collecting area, the boxes which consistently attracted the largest number of mosquitoes were retained; others were removed. Once a week each box was visited, and all the mosquitoes that could be collected from it by aspirator composed the station collection. From 5 to 8 box stations were used at Jerry Slough and 5 or less in the other two areas.

3. Light Traps. New Jersey and American type light traps (Mulhern, 1953) were used with a 25-watt bulb frosted white inside. The traps were started automatically or manually at least an hour before sunset and were run until the following morning, when the collector removed the cloth collecting cage which substituted for the usual cyanide jar. Light traps were operated at 4 stations in Jerry Slough and at one station in each of the other areas.

4. Bait Traps. Portable lard can bait traps (Bellamy and Reeves, 1952) were operated with dry ice (CO_2) bait. The standard bait was a rectangular block of dry ice weighing about 2.5 pounds, wrapped in a double layer of 50 weight Kraft paper, and closed securely with strips of two-inch-wide 60 weight gum paper tape. At the time a trap was baited, usually in the afternoon, approximately one-half inch openings were cut in four sides of the wrapping to permit escape of the CO_2 gas. Some dry ice usually remained in the trap the following morning unless it had been exposed to excess afternoon sun or unusually high night temperatures. In the morning, before transporting the traps to the laboratory, the trap openings were plugged with cotton to prevent the escape of trapped mosquitoes. The traps were operated in a horizontal position in a variety of places, such as on the ground, in tree crotches, and on top of buildings. Some bait trap stations which were not productive were abandoned and new stations were selected. Traps were generally operated at 4 stations in Jerry Slough and at 2 to 6 stations at Hart Park and Arkelo Olive Grove.

Collecting Schedule

For all four collecting methods, once established, a station remained the same throughout the major part of the study, with exceptions as noted. Insofar as possible, from June 1, 1953, through June 30, 1954, light trap collections and those from natural and artificial shelters were made regularly in the three study areas, one collection at each station every week. Bait trap stations were selected in the late summer 1953, and bait traps were operated more or less regularly until winter (December to March, inclusive), when the traps were operated irregularly about once each month. Beginning in April 1954 they were operated once each week.

In some studies, a time limit factor has been used to standardize mosquito collections at stations, e.g., a collection would consist of all mosquitoes that could be captured in ten minutes. In this study the time limit concept was never employed; instead, thoroughness was stressed, the objective being a complete collection of all specimens at an artificial or natural shelter. If possible the collections were made at the same time of day at specific stations each week. To avoid unfavorable effects of high summer temperatures, collection from shelters was begun early enough in the morning to permit completion of the day's collections by noon.

STATISTICAL ANALYSES

Two principal methods of analysis were selected following a number of preliminary analyses and graphic considerations of raw data.

First, weekly arithmetic mean numbers of specimens were determined for each method of collection in each study area. For example, for a given week the total number of female *C. tarsalis* collected by light traps at Jerry Slough was divided by the number of light trap collections made in Jerry Slough during that week. A similar calculation was made for males. The weekly means were converted to biweekly means by taking half the sum of the means of two consecutive weeks. Averages for periods greater than two weeks were undesirable, as seasonal population trends would be obscured.

Second, the biweekly means, obtained as indicated above, for each collecting method at each study area, were ranked according to magnitude, and Spearman's method of rank correlation (Snedecor, 1946) was utilized in making comparisons. By this method it was possible to compare the year-around population trends as measured by the different collecting methods, or by a single collecting method in different study areas. It was also possible to compare the results from a single collecting method at replicate stations within a study area by this procedure.

In performing Spearman's correlation, the biweekly means for any given collecting method at any study area were ranked: the largest biweekly mean for the period of the study was given the highest rank and the smallest biweekly mean the lowest; the others according to magnitude were ranked between. Spearman's formula, $r = 1 - \frac{6 \Sigma d^2}{n (n^2 - 1)}$ was utilized in making the rank correlations. The standard deviation of the rank correlation is $\frac{1}{\sqrt{N-1}}$.

RESULTS

The biweekly means of female *C. tarsalis* collected by each of the four sampling methods in the three study areas are shown in Table 1 and Figure 1. The size of samples varied widely in magnitude, but regardless of the method of sampling or area studied, there was a striking similarity in population trends. The population exhibited a marked increase in late spring and built up to a summer peak which was then followed by a distinct autumn decline. In the winter, results from the several sampling methods diverged widely. Natural shelter collections in the Jerry Slough and Hart Park areas yielded comparatively large samples, and there was even an apparent increase in the shelter population at Hart Park. Only small numbers of specimens were taken in collections by light traps and bait traps and from artificial shelter units. Adult female *tarsalis* were taken in light trap collections and from artificial shelters in each winter month, but in only small numbers from December through March. Bait traps produced still fewer specimens in the winter season, none in December or March, but bait traps were operated infrequently during the winter. The winter population of female *C. tarsalis* in Arkelo Olive Grove was minimal; specimens were collected each month but in small num-

FIG. 1.

AVERAGE NUMBER OF *Culex tarsalis* FEMALES COLLECTED DURING TWO WEEK PERIODS IN THREE STUDY AREAS OF KERN COUNTY BY FOUR SAMPLING METHODS

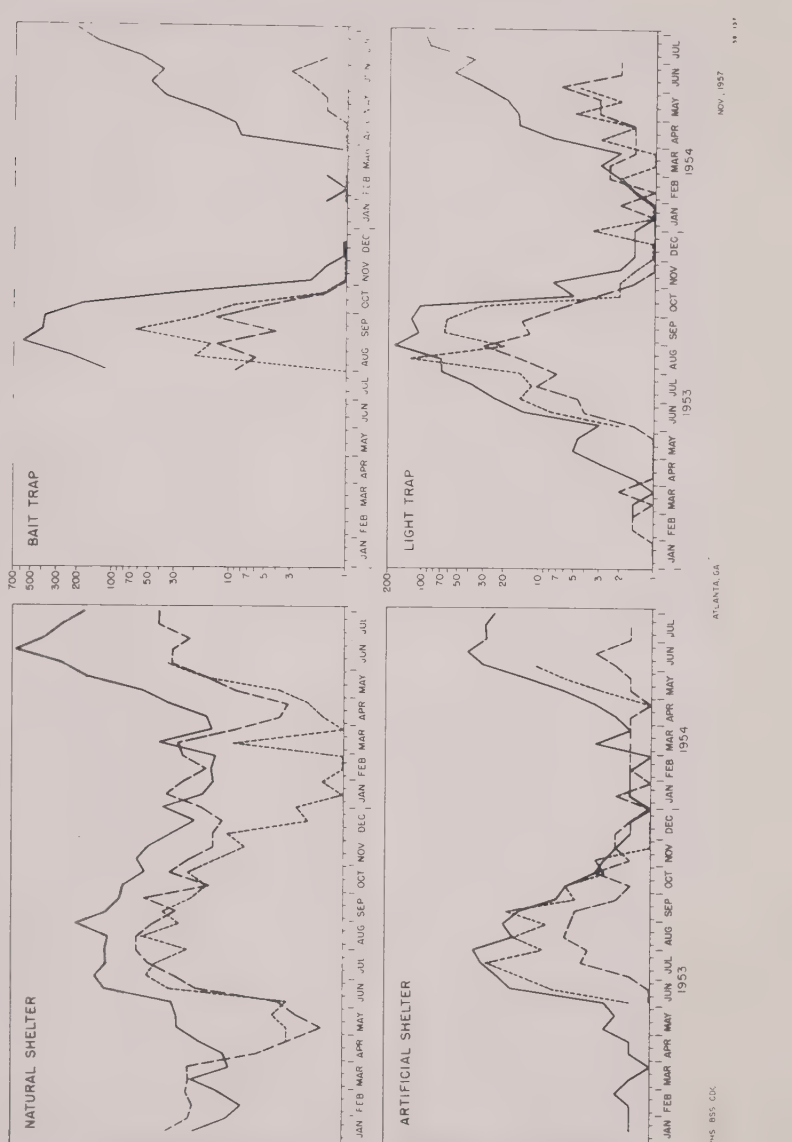

TABLE 1.—Average number of *Culex tarsalis* females collected during two-week periods in three study areas of Kern County by four sampling methods

Inclusive Dates 1953–54	Jerry Slough				Olive Grove				Hart Park			
	NS	AS	LT	BT	NS	AS	LT	BT	NS	AS	LT	BT
Jan. 8–21	18.5	0.5	–	–	–	–	–	–	32.0	–	0.0	–
Jan. 22-Feb. 4	9.0	0.5	–	–	–	–	–	–	20.0	–	0.0	–
Feb. 5–18	6.5	0.5	–	–	–	–	–	–	18.5	–	0.5	–
Feb. 19-Mar. 4	11.0	1.0	0.5	–	–	–	–	–	21.0	–	0.5	–
Mar. 5–18	19.5	0.5	0.5	–	–	–	–	–	20.0	–	0.0	–
Mar. 19-Apr. 1	8.5	0.0**	0.0	–	–	–	–	–	20.5	–	1.0	–
Apr. 2–15	9.5	0.5	0.5	–	–	–	–	–	4.5	–	0.0	–
Apr. 16–29	16.5	0.5	2.0	–	2.0	–	–	–	2.0	–	0.0	–
Apr. 30-May 14	25.5	1.5	4.0	–	2.0	–	–	–	0.5	–	0.0	–
May 15–28	26.0	1.0	3.5	–	3.0	–	–	–	1.5	–	0.0	–
May 29-June 11	28.5	1.5	2.0	–	2.0	0.5	1.0	–	2.5	0.0**	0.5	–
June 12–25	112.0	15.0	13.0	–	30.0	6.0	7.0	–	17.0	0.0	3.0	–
June 26-July 9	133.0	20.0	23.5	–	47.5	12.5	13.5	–	27.0	0.5	3.5	–
July 10–23	107.5	28.0	37.5	–	39.5	25.5	10.5	–	45.0	3.0	9.5	–
July 24-Aug. 6	109.0	33.0	67.5	114.5	20.5	7.5	13.5	0.0	57.5	2.5	6.0	8.0
Aug. 7–20	102.5	14.5	68.5	228.5	53.0	14.5	127.5	19.0	57.5	4.5	13.0	5.0
Aug. 21-Sept. 3	194.0	18.0	173.5	579.5	24.5	7.0	19.0	13.5	41.5	4.0	29.0	12.0
Sept. 4–17	108.0	13.0	109.0	395.5	33.5	16.5	63.5	62.5	26.0	3.5	11.0	3.0
Sept. 18-Oct. 1	82.5	5.5	125.0	378.0	19.0	3.5	61.0	19.0	50.5	1.0	13.0	12.0
Oct. 2–15	76.5	4.5	105.0	179.0	14.0	4.5	31.0	8.0	13.0	0.5	5.5	4.0
Oct. 16–29	49.5	2.0	4.0	20.5	20.5	1.5	1.0	0.5	30.0	2.0	2.0	0.5
Oct. 30-Nov.12	58.0	1.5	6.5	1.0	11.5	2.0	1.0	0.0	25.0	0.5	0.5	0.0**
Nov. 13–26	45.5	1.0	1.0	0.5	6.0	0.0**	0.5	0.0	12.0	1.0	0.0	0.0
Nov. 27-Dec.10	29.5	0.5	0.5	0.0	9.0	0.0	0.0	0.0	12.0	1.0	0.0	0.0
Dec. 11–24	18.0	0.5	0.5	0.0	1.0	0.0	0.0	0.0	10.0	0.5	0.0	0.0
Dec. 25-Jan. 7	35.0	0.0	0.5	–	1.5	–	2.5	–	15.5	0.0**	0.0	–
Jan. 9–21	15.0	0.5	0.0**	–	0.0	–	0.0	–	32.0	1.0	0.0	–
Jan. 22-Feb. 2	12.0	0.5	0.0	0.5	0.5	–	0.0	0.0	22.5	0.0**	1.0	0.0
Feb. 5–18	12.5	0.5	0.5	0.0	0.0	–	0.5	0.0	14.0	0.5	0.0	0.0
Feb. 19-Mar.4	11.5	0.0	1.0	0.5	0.0	–	1.0	0.0	23.0	0.5	1.5	0.0
Mar. 5–18	37.0	2.0	2.0	–	8.0	–	0.0	–	25.5	0.5	1.5	–
Mar. 19-Apr. 1	12.5	0.5	1.0	0.0	0.0	–	0.0	0.0	7.5	0.5	0.5	0.0
Apr. 2–15	14.0	1.0	6.5	7.0	0.5	–	2.0	0.0	2.5	0.5	0.5	0.0**
Apr. 16–29	30.5	2.0	14.0	8.0	1.0	0.0	0.5	0.0	2.0	0.0	0.5	0.0
Apr. 30-May 13	52.5	4.5	14.5	15.0	2.5	1.5	4.0	0.0**	7.5	0.5	2.0	0.5
May 14–27	161.0	11.0	18.5	34.5	14.0	4.5	1.0	0.0	14.0	0.5	2.0	0.5
May 28-June 10	262.5	27.5	30.0	47.5	31.0	9.0	3.5	0.0**	29.0	1.0	5.5	1.0
June 11–24	643.0	38.0	53.5	35.5	–	–	–	–	28.5	2.0	1.0	2.0
June 25-July 8	362.0	26.0	36.0	57.0	–	–	–	–	20.0	0.5	1.0	0.5
July 9–22	258.0	26.5	87.0	132.0	–	–	–	–	37.0	0.5	–	–
July 22-Aug. 5	176.0	22.0	94.5	202.5	–	–	–	–	35.0	–	–	–

** Mosquitoes collected but average less than 0.25.

TABLE 2.—Average number of *Culex tarsalis* males collected during two-week periods in three study areas in Kern County by four sampling methods.

Inclusive Dates 1953–54	Jerry Slough				Olive Grove				Hart Park			
	NS	AS	LT	BT	NS	AS	LT	BT	NS	AS	LT	BT
Jan. 8–21	0.0**	0.0	–	–	–	–	–	–	0.0	–	0.0	–
Jan. 22-Feb. 4	0.0	0.0	–	–	–	–	–	–	0.0	–	0.0	–
Feb. 5–18	0.0	0.0	–	–	–	–	–	–	0.0	–	0.0	–
Feb. 19-Mar. 4	0.0	0.0	0.0	–	–	–	–	–	0.0	–	0.0	–
Mar. 5–18	0.0	0.0	0.0	–	–	–	–	–	0.0	–	0.0	–
Mar. 19-Apr. 1	0.0**	0.0	0.0**	–	–	–	–	–	0.0**	–	0.0	–
Apr. 2–15	3.0	0.0	0.0	–	–	–	–	–	0.5	–	0.0	–
Apr. 16–29	4.0	0.5	1.0	–	1.5	–	–	–	0.5	–	0.0	–
Apr. 30-May 14	10.0	1.0	0.0	–	1.0	–	–	–	1.0	–	1.0	–
May 15–28	7.0	1.5	0.5	–	1.5	–	–	–	1.0	–	0.5	–
May 29-June 11	5.0	1.0	0.5	–	1.0	0.0	0.0	–	2.0	0.0	0.0	–
June 12–25	17.5	5.0	3.5	–	6.0	3.0	0.0	–	4.0	0.0	0.0	–
June 26-July 9	30.0	6.0	3.5	–	22.5	5.5	13.0	–	11.0	1.0	0.0	–
July 10–23	15.5	4.5	4.0	–	11.0	10.5	4.0	–	16.0	2.0	3.0	–
July 24-Aug. 6	11.5	3.5	1.5	0.5	9.0	2.5	16.0	0.0	9.0	2.0	3.0	0.0
Aug. 7–20	9.0	1.0	2.0	0.0	21.5	6.0	89.0	0.0	8.0	1.5	2.5	0.0
Aug. 21-Sept. 3	21.5	3.0	8.0	0.0**	22.5	8.5	8.0	0.0	12.5	2.0	2.5	0.0
Sept. 4–17	23.0	5.5	13.0	0.0	30.0	20.0	28.5	1.0	14.5	2.0	5.5	0.0
Sept. 18-Oct. 1	25.5	2.5	9.0	0.0	37.0	11.0	26.0	1.5	35.5	0.5	4.5	0.0
Oct. 2–15	46.0	4.0	25.0	0.0	25.0	10.0	44.5	1.0	26.5	1.5	11.0	0.5
Oct. 16–29	41.0	2.5	19.5	0.0**	28.0	2.5	31.0	0.0	35.5	0.5	11.0	0.0**
Oct. 30-Nov. 12	38.5	2.0	48.0	0.0**	8.5	2.0	6.5	0.0	35.0	0.5	8.0	0.5
Nov. 13–26	22.5	0.5	5.0	0.0	1.5	0.5	0.0	0.0	9.0	0.0**	1.0	0.0**
Nov. 27-Dec. 10	4.5	0.0	1.5	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0
Dec. 11–24	0.0**	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0**	0.0	0.0	0.0
Dec. 25-Jan. 7	0.0	0.0	0.0	–	0.0	–	0.0	–	0.0	0.0	0.0	–
Jan. 8–21	0.0	0.0	0.0	–	0.0	–	0.0	–	0.0	0.0	0.0	–
Jan. 22-Feb. 4	0.0	0.0	0.0	0.0	0.0	–	0.0	0.0	0.0	0.0	0.0	0.0
Feb. 5–18	0.0	0.0	0.0	0.0	0.0	–	0.0	0.0	0.0	0.0	0.0	0.0
Feb. 19-Mar. 4	0.0	0.0	0.0	0.0	0.0	–	0.0	0.0	0.0	0.0	0.0	0.0
Mar. 5–18	0.0**	0.0	0.0	–	0.0	–	0.0	–	0.0	0.0	0.0	–
Mar. 19-Apr. 1	0.5	0.0**	0.5	0.0	0.0	–	0.0	0.0	0.0	0.0	0.0	0.0
Apr. 2–15	5.0	0.5	0.0**	0.0	0.0	–	0.5	0.0	0.5	0.0	0.0	0.0**
Apr. 16–29	13.5	1.5	3.0	0.0	1.5	0.0	0.0	0.0	1.0	0.5	0.0	0.0
Apr. 30-May 13	16.5	2.5	3.5	0.0	2.0	0.5	2.0	0.0	4.0	0.0**	0.0	0.0
May 14–27	70.5	7.0	6.0	0.0	3.0	2.5	1.5	0.0	8.5	0.0**	1.5	0.0
May 28-June 10	151.5	21.5	17.0	0.0**	10.0	3.0	2.5	0.0	12.5	0.5	0.5	0.0
June 11–24	553.0	42.5	66.0	0.5	–	–	–	–	11.0	1.0	0.0	0.0
June 25-July 8	192.0	20.0	17.0	0.0	–	–	–	–	4.5	0.5	0.0	0.0
July 9–22	23.0	8.5	9.5	0.0	–	–	–	–	9.0	0.5	–	–
July 23-Aug. 5	25.5	6.0	23.5	0.0	–	–	–	–	7.0	–	–	–

** Mosquitoes collected but average less than 0.25.

bers and not consistently by any method.

The biweekly mean number of male *C. tarsalis* collected in the Jerry Slough study area by the four sampling methods are shown in Table 2. Only occasional males were taken in bait traps. In each study area, males reappeared in natural shelters prior to the major spring population increase of females. Results from the various sampling methods (except those from bait traps) at each study area, indicate a parallel springtime upward trend of the female and male populations. In both winters of the study, 1952–53 and 1953–54, males were almost wholly absent from collections from late December to early March. In the spring, males were detected most consistently in collections from natural shelters, and were taken irregularly and in small numbers at light traps and artificial shelters.

Table 3 gives the rank correlation coefficients for 18 intra-area and 12 inter-area comparisons for females and 9 of each type comparison for males. Two types of comparison are made. The intra-area correlation coefficients show the strength of agreement between different sampling methods in depicting the year around population trends within a single study area, and the inter-area correlation coefficients are similar measures of agreement of results from a single sampling method in two different study areas. Bait trap collections of males are excluded from these comparisons since males are seldom taken in bait traps.

TABLE 3.—Intra-area and inter-area rank correlation coefficients for two-week *Culex tarsalis* collection averages. (female above diagonal x entries, male below)

		Jerry Slough Area				Olive Grove Area				Hart Park Area			
		NS	AS	LT	BT	NS	AS	LT	BT	NS	AS	LT	BT
Jerry Slough Area	NS	x	.87	.82	.70	(.91)	–	–	–	(.96)	–	–	–
	AS	.93	x	.86	.80	–	(.87)	–	–	–	(.45)	–	–
	LT	.81	.73	x	.96	–	–	(.88)	–	–	–	(.78)	–
	BT	*	*	*	x	–	–	–	(.83)	–	–	–	(.95)
Olive Grove Area	NS	(.85)	–	–	–	x	.91	.74	.76	(.57)	–	–	–
	AS	–	(.63)	–	–	.89	x	.78	.67	–	(.55)	–	–
	LT	–	–	(.70)	–	.87	.72	x	.82	–	–	(.83)	–
	BT	–	–	–	(*)	*	*	*	x	–	–	–	(.84)
Hart Park Area	NS	(.91)	–	–	–	(.92)	–	–	–	x	.69	.60	.71
	AS	–	(.72)	–	–	–	(.73)	–	–	.81	x	.51	.72
	LT	–	–	(.65)	–	–	–	(.83)	–	.80	.75	x	.89
	BT	–	–	–	(*)	–	–	–	(*)	*	*	*	x

NS—Natural Shelter
AS—Artificial Shelter.
LT—Light Trap.
BT—Bait Trap.
*—No comparison; insufficient numbers collected for ranking.
Coefficients in parentheses are inter-area comparisons.
All coefficients in this table show significantly positive correlation at the 5 percent probability level or less.

The minimum number of paired ranks used in preparing Table 3 was 15. The maximum value of the standard deviation equals 0.267. All intra-area and inter-area comparisons showed significantly positive correlation coefficients at the five percent probability level. Increases and decreases in the ranks of biweekly means from one method of collection were usually accompanied within a given study area by similar changes in the ranks of the biweekly means from the other methods of collection. For a single collecting method, the ranking of the biweekly means tended to show the same trends in different study areas. The exceptions were so infrequent that they did not destroy the significance of the correlation. The comparatively large numbers of specimens in the winter natural shelter collections from Hart Park affected the rankings from that area, but the correlation is still at the significant level (Table 3).

A further test was made of the agreement between the results from one collecting method at different collecting stations in the same study area. Data from Jerry Slough natural shelter stations which differed widely in the average number of mosquitoes present were selected for comparison by rank correlation. These were designated station 1 (best), station 2 (good), station 3 (fair), and station 4 (worst), in order of decreasing numbers of specimens found. Collections from each station were ranked and compared. The rank correlation coefficients are presented in Table 4. For each coefficient, the number of pairs compared was 30, so the standard deviation of the coefficient equals 0.186. At the five percent probability level, all coefficients were significantly positive except those involving the "worst" station which yielded irregular and small number samples.

Similar comparisons were made using the data on males and females from the four light trap stations and from four of the eight artificial shelter stations at Jerry Slough. Data on females from the four bait trap stations in Jerry Slough were similarly ranked and compared. In all cases significantly positive correlations were obtained, but the detailed results are not presented because of their similarity to the previous example.

No emphasis was placed on the determination of population trends of the other species of mosquitoes collected by the several sampling methods, but the following general observations were made:

Culiseta inornata was most abundant during the fall and winter and was the only species, other than *C. tarsalis,* taken at light traps during January and February. *C. inornata* was not collected in August. *Culex quinquefasciatus* was found in natural and artificial shelters in increasing numbers through summer and fall, and was taken infrequently and in only small numbers in late winter and spring. During October and November of 1953, *C. quinquefasciatus* was the principal species taken in bait traps. *Culex stigmatosoma* was found in greater abundance in collections from natural shelters than in other collections. Its population reached a peak in July and August.

TABLE 4.—Rank correlation coefficients for selected natural shelter stations in the Jerry Slough area based on two-week female and male *Culex tarsalis* collection averages

Station		Station No. 2 (Good)	Station No. 3 (Fair)	Station No. 4 (Worst)
Station No. 1 (Best)	Female	.53	.73	.21
	Male	.86	.82	.52
Station No. 2 (Good)	Female	–	.61	.03
	Male	–	.76	.48
Station No. 3 (Fair)	Female	–	–	.30
	Male	–	–	.66

Values greater than 0.37 represent significantly positive correlation at 5 percent probability level.

The largest populations of *Aedes nigromaculis* and *A. melanimon* occurred at Jerry Slough, and the largest numbers of specimens were taken in light trap collections. As measured by light trap collections at Jerry Slough, small populations of these species took wing in late April and May, and there were noticeable waves of increasing abundance through the summer, climaxing in the largest populations in late August and early September, with the populations receding rapidly in October and early November. *Anopheles freeborni* and *A. franciscanus* were most commonly collected in shelters or by light trap but were never abundant.

DISCUSSION

Comparison of four collecting methods in three different study areas minimized the chance that characteristics peculiar to a single study area would lead to misevaluation and increased confidence in the general applicability of the findings. The positive relationships noted by rank correlation coefficient evaluation between areas and between all collecting methods substantiate the value of the sampling procedures for measuring adult *C. tarsalis* populations. Comparison of samples collected by each sampling method at replicate stations in a small area indicates that any single well selected station will provide a representative measure of annual population trends.

Some of the observed merits and limitations of the different sampling methods are:

NATURAL SHELTER: Merits. 1. If good stations are selected, the natural shelter unit provides the largest collections and is the most sensitive unit on a year around basis.

2. Presumably, collections from natural shelters are the most nearly representative cross-section of the adult population, i.e., all fractions of the population are represented: males, females with blood, gravid females, freshly emerged specimens, etc.

Limitations. 1. It is essentially impossible to standardize collections from natural shelters for comparison with results in other geographic areas, because natural shelter units are so variable in size, shape, and permanence.

2. A station which is sensitive enough to be positive at the time of minimal populations may well provide so many specimens at the time of peak population that collecting and identifying the specimens is a real burden.

3. Some units are attractive to mosquitoes at one season but less attractive at another.

ARTIFICIAL SHELTER: Merits. 1. As in natural shelters the general population is sampled, although in smaller numbers, on a year around basis.

2. The artificial shelter is a standard unit in dimensions, therefore comparisons between units have more validity than for natural shelters.

3. These units are readily portable and non-mechanical and they can be placed where there are no suitable natural shelters.

Limitations. 1. Insufficient numbers of specimens may be attracted to some units; the sensitivity of good natural shelters is not provided.

2. Some experience in placing units at suitable locations is necessary and poor choice of location will result in unsatisfactory stations.

LIGHT TRAP: Merits. 1. The unit is widely utilized by mosquito control agencies as a standard. This permits comparisons, with some limitations, between geographic areas.

2. There is minimal chance of an environment being changed so this unit cannot be operated, thus comparisons can be made with recorded results for previous years at a specific location.

3. Both male and female *C. tarsalis* are attracted.

Limitations. 1. Collections are difficult to handle and require much sorting of miscellaneous insects.

2. The ordinary unit can be operated only where a suitable source of power is available.

3. Power failures or mechanical trap failures may occur.

4. Freshly engorged and gravid females are not adequately sampled.

Carbon Dioxide Bait Trap: Merits. 1. The (presumably) blood-seeking fraction of the female population is attracted.

2. Collections are free of other insects, debris, etc., and are therefore easy to handle.

3. The unit can be standardized easily.

4. The unit can be placed in any location and is not subject to mechanical failure.

Limitations. 1. There is no measure of the male or engorged and gravid female portion of the population.

2. The unit is not attractive to mosquitoes in cold weather.

3. The bait must be placed in the unit each night it is to be run.

From the above critique of the several collecting methods, it is obvious that one method may serve one purpose best but may be ineffective for another. Thus, the epidemiologist will probably be most vitally interested in the vector attack rate and, of the above methods, the dry ice baited trap is the method of choice. On the other hand, a mosquito control agency may be concerned with the numbers of male specimens both as an indication of proximity to breeding areas and as a sign of recent emergence. In this case, the bait traps are not the answer. Either shelter collections or light trap collections are indicated, with the light traps providing a somewhat greater chance than the shelters of being maintained without alteration. The entomologist may wish to maintain as complete a picture as possible of the population. If so, he will obtain important data from all four methods. For a single method, the shelter collections probably would give the most complete data.

It is important that stations be chosen carefully. This has been noticed particularly in placing the red box artificial shelter units. In a number of instances these have been placed where few mosquitoes were attracted, while at a nearby location an identical unit would attract many more specimens. It is recommended that in placing such units for preliminary trials, three or four boxes be installed at a location where it is desired to locate one permanently. After a number of observations, one unit may be seen to attract many more mosquitoes than the others. This best unit can be used as the permanent station and the others discontinued.

In this study, the populations in the three study areas were undoubtedly affected to some degree by mosquito control measures. No attempt was made to measure the effect of mosquito control activities on the *C. tarsalis* population.

Summary

Four methods of collecting adult *Culex tarsalis* were compared through a period of more than a year at three localities in Kern County, California. The collections were made by: aspirator in natural shelters, aspirator in one-cubic-foot red box artificial shelters, mosquito light traps, and dry ice (CO_2) baited traps.

All methods proved satisfactory for measuring the abundance of adult female *C. tarsalis* in the summer. All methods except bait traps adequately sampled male *C. tarsalis*. There was close agreement between the population trends indicated by the different collecting methods within single areas and by each collecting method in the three localities.

Each of the four sampling methods has advantages and limitations for *C. tarsalis* population measurement depending on whether the application is to mosquito control, epidemiological or biological studies.

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PREPARATION OF THICK MALARIAL BLOOD SMEARS BY THE TAPPING METHOD

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The usual method of preparing thick blood smears for diagnosis and study of malarial parasites consists in using the tip of a toothpick or the point of another slide to run together and mingle three large, adjacent drops of blood, so as to form a round smear about the size of a dime. The parasites are then sought throughout the circular smear because they have not been localized or concentrated in any manner.

In 1954, while the writer was stationed in Monrovia, Liberia with the U. S. Operations Mission to Liberia, the German laboratory supervisor at the Liberian Government Hospital, Miss Freya Weber, showed him the method which was used by her in the preparation of thick blood smears, and which has advantages over the usual method. Her method was as follows:

1. After puncturing the ear lobe or finger, place a very large drop of blood on the slide about one-half inch from one end in the center of the slide.

2. Tap the opposite end of the slide gently on the table, until the blood flows for about one inch or slightly more along the length of the slide.

3. Let the slide dry in air, propped up at an angle, so that the distal end of the smear consists of a large blob of dried blood.

4. Stain as usual with Giemsa stain. (Staining for 60 minutes and washing for 5 minutes are recommended.)

If any parasites are present, most of them usually flow down into the concentrated portion and are found comparatively quickly. This method has some disadvantages: (1) the stain does not usually penetrate the concentration completely, although enough of it is stained to permit finding the parasites; (2) it does not readily permit making of more than one thick and thin smear on the same slide; and (3) after the thick smear has dried there is danger of flaking of the crust at the concentrated end, while the slides are being carried around in the field or being jolted around in a jeep, prior to being stained.

While assigned as Malariologist with the U. S. Operations Mission, Kathmandu, Nepal, the writer was confronted with a shortage of slides and with certain personnel problems which necessitated the adoption of the simplest possible method for preparing thick and thin blood smears under the conditions that prevailed. After much experimentation with variations on the tapping method, the following procedure was adopted. (Refer to Figs. A & B.)

1. After puncturing the ear lobe or finger, place one good-sized drop of blood about ⅛ inch from the long edge, about ⅔ of the way along the slide.

2. Holding the slide with the long edge parallel to the table top, gently tap the slide vertically against the table top until the blood has flowed transversely across the slide for a distance of ⅝ to ¾ inch.

3. Let the slide dry in air, *flat and horizontally*, so that the blood forms a narrow, even film about ⅛ inch wide and ⅝ to ¾ inch long.

4. If only the thick smear is desired, no other procedure is necessary; however, if a thin smear is also desired, it should be made *prior* to the thick smear, beginning at about ¾ inch from the right end of the slide. It is very important that a *very*

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small drop be used for the thin smear so that only one layer of erythrocytes results.

5. After the thick smear has dried, a second thick (and thin) smear from another child may be made at the other third of the slide.

This latter method has the following advantages: (1) it permits making of both thick and thin smears from two different persons; (2) if thick smears alone are desired, the tapping method avoids the use of a second slide or a toothpick for mingling separate drops of blood; (3) a narrow, uniform blood film is formed which stains uniformly and is easily examined because of its shape; and (4) a saving in slides used is effected due to the doubling up of thick and thin smears.

In practice the slides were kept in boxes of 100 slides each, previously numbered at the upper right with a diamond-pointed pencil. One hundred slides were made consecutively, at the right third of the slide, after which the second hundred smears were made at the left third of the same slides. The smears at the right were given the original numbers of the slides, such as 101, 102, 103, etc., whereas those at the left were prefixed with the letter "L" meaning "left side," such as "L101," "L102," "L103," etc. If desired, "A" can be used instead of "L," it being understood that a letter prefixing the number refers to the smear at the left. No actual number need be written on the slide at the left side.

It is important that the slide be kept flat and horizontal during drying of the thick smear, and in a protected place away from heat of any kind. A cardboard slide tray was found to be very valuable for this purpose; by propping up the two halves of the cover with small sticks or pebbles, drying occurred with a minimum of exposure to flies. A large flour strainer is also useful for keeping flies away from drying slides in the field.

Fixing of thin smears was done as soon as conditions were favorable. This was accomplished by dipping a narrow strip of paper towelling or toilet tissue into methyl alcohol and sliding it rapidly off the thin smear while the slide was held flat in the hand. Slides which are being fixed should be kept away from drafts, windows, and operating fans, as it was found that the alcohol vapor could be wafted over the thick smear, thus fixing and ruining the latter. Once a thick smear has been accidentally fixed with methyl alcohol liquid or vapor, there is no way the smear can be "unfixed" or restored to its original condition, any more than a boiled egg can be restored to its original condition.

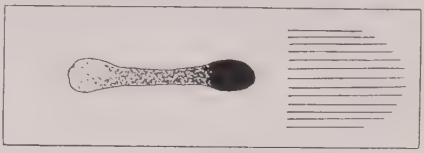

Fig. A

Fig. B

Figure A shows the thick smear prepared by the first tapping method described, with a thin smear at right.

Figure B shows two sets of thick and thin smears prepared as described; the thick smears shaped as usually occurs after tapping.

Summary. A thick malarial blood smear can be easily prepared by tapping the slide against a table top or other surface, so that a large drop of blood flows transversely across the slide for a distance of ⅝ to ¾ inch, after which the slide is permitted to dry in air in a flat position. A narrow, even film results which is very convenient in searching for malarial parasites. The need for mingling several adjacent drops of blood with some object, as usually done, is therefore obviated.

AEDES SOLLICITANS AND *A. TAENIORHYNCHUS* LARVAL EMERGENCE FROM SOD SAMPLES[1]

C. M. ELMORE, JR., AND R. W. FAY

One method for evaluating the mosquito production potential of various salt marsh areas has been based on counts of larvae from flooded sod samples. The present study on the sod sampling technique was made to determine the variation in the numbers of larvae hatching introduced by different temperatures prior to and at the time of flooding, by the original distribution of the mosquito eggs, and by seasonal differences in the time of flooding.

A salt marsh area located about one-half mile north of the Savannah River near Elba Island, Georgia, was selected for study. The area, essentially level and about 8 feet above mean low water, was flooded only by the highest spring tides and by heavy rainfall. Plant growth was a uniform stand of *Distichlis spicata* which had been burned off to about 2 inches above the surface in late December, 1955.

On January 9–10, 1956, 108 sod samples of 0.2 sq. ft. each were cut to a depth of 2 inches from an 11 x 22 ft. area. Each sample was boxed in a 1-gallon cardboard container. On January 11, groups of 36 samples were stored at 60°, 70°, and 80° F., respectively. Initial flooding at each of the three storage conditions was begun on the same day. For flooding, a sample was transferred to a battery jar and sufficient water was used to cover plant material during a 24-hour period. Three sod samples were flooded each day for 12 days so that the last samples were under storage conditions, including the 24-hour flooding period, for 12 days. After a flooding period, the water was poured off carefully and the larvae were designated as hatch 1. Each sample then was held for an additional 10 days at 80° F. and 70 percent relative humidity and then reflooded for 24 hours. Larvae secured were designated as hatch 2. The viable egg population was taken as the sum of the two hatches for any given sod sample.

The effects of air temperature and of flood water temperature at the three storage conditions upon the hatching of salt-marsh mosquito eggs were measured by comparing the numbers of larvae from hatch 1 with the total larvae from hatches 1 and 2, for each three samples at each test interval. These results (table 1) demonstrate that storage of the sod at 60° F. and flooding with water at 60° F. did not produce any increase in the hatch over the 12-day test period. After 7 days at 70° F., there was some increase in hatch. After 3 days at 80° F. there was an essentially continuous increase in the percentage of eggs hatching, passing the 90 percent level on the seventh day. Although there is a progressive increase in the total larvae from hatch 1 and 2 for storage conditions of 60°, 70°, and 80° F., this increase was not statistically significant.

Larvae, recovered from flooding each set of three sod samples under given conditions, were combined and a random sample of 25 first instar larvae was taken for species identification. The remaining larvae were reared using 200 larvae in 1 liter of tap water for each porcelain enamel pan. A second sample of 25 larvae for identification was taken when the larvae reached the fourth instar.

First instar larvae of *Aedes sollicitans* and *A. taeniorhynchus* were readily distinguished under the microscope by the arrangement of the four subapical and terminal antennal hairs. *A. sollicitans* has two long and two short hairs while *A. taeniorhynchus* has one long and three

[1] From the Communicable Disease Center, Bureau of State Services, Public Health Service, U. S. Department of Health, Education, and Welfare, Savannah, Georgia.

TABLE 1.—Salt marsh mosquito eggs hatching from sod samples after storage and flooding under test conditions. Values represent combined results of three sod samples

Days of Conditioning [1]	Store at 60° F.			Stored at 70° F.			Stored at 80° F.		
	Hatch 1	Hatch [2] 1 and 2	Percent (Hatch 1)	Hatch 1	Hatch [2] 1 and 2	Percent (Hatch 1)	Hatch 1	Hatch [2] 1 and 2	Percent (Hatch 1)
1	33	570	6	14	688	2	61	556	11
2	37	1040	4	40	935	4	107	1069	10
3	11	1111	1	124	603	21	182	804	23
4	33	1301	2	32	663	5	614	1081	57
5	14	447	3	16	321	5	407	622	65
6	5	341	2	84	799	11	1153	1386	83
7	13	1358	1	34	180	19	1226	1308	94
8	19	577	3	835	2698	31	425	446	95
9	34	674	5	247	984	25	1587	1718	92
10	38	392	10	106	445	24	871	964	90
11	43	797	5	390	1068	36	568	591	96
12	14	616	2	247	818	30	546	553	99
Total	294	9224		2169	10202		7747	11098	

[1] Days of conditioning include days of storage and a 24-hour flood period at storage conditions.

[2] Hatch 1 & 2 or total hatch includes original storage & flooding and additional 10-day storage at 80° F. and 70 percent relative humidity and a second 24-hour flooding period.

short hairs. Under storage and flooding conditions of 60° F., the larvae produced were *A. sollicitans; A. taeniorhynchus* represented less than 3 percent in the total first instar larvae identified. With conditioning at 70° F., samples for 1 to 3 days produced no *A. taeniorhynchus* larvae, and then the proportion of this species gradually rose so that the 7- to 12-day samples showed the two species in about equal numbers. At 80° F., only a few *A. taeniorhynchus* hatched in 1 or 2 days of conditioning. Thereafter, the numbers of *A. taeniorhynchus* rapidly exceeded those of *A. sollicitans.* Using the proportions represented in the identified first instar samples for hatch 1 and hatch 2, calculations of the number of each species in the total hatch of 30,536 larvae gave three estimates of species distribution from combined 60°, 70°, and 80° tests, namely: *A. sollicitans,* 21.2, 22.4, and 22.3 percent; and *A. taeniorhynchus,* 78.8, 77.6, and 77.7 percent. Based on the combined results for all temperatures, the values were *A. sollicitans,* 22.0 percent and *A. taeniorhynchus,* 78.0 percent.

Although *A. sollicitans* larvae were essentially all that emerged at 60° F., only about 25 percent of the available *A. sollicitans* eggs hatched when results from hatch 2 were considered. Under 70° F. conditioning for 1 to 6 days, about 40 percent of the *A. sollicitans* eggs hatched, with 7 to 12 days conditioning about 70 percent of the eggs hatched. Only 1 percent of the *A. taeniorhynchus* eggs hatched during the first 6 days at 70° F. and about 16 percent with 7 to 12 days of conditioning. At 80° F. about 40 percent of each species hatched with 1 to 6 days of conditioning and about 95 percent with 7 to 12 days conditioning.

The samples of fourth instar larvae taken from the rearing pans also were used to estimate the species proportions. The two species were distinguished primarily by differences in the comb scales on the eighth abdominal segment. Using the proportions in the identified fourth instar samples for hatch 1 and hatch 2, calculations of the number of each species in the total pupal production and the fourth instar samples (11,738 individuals) were made. For purposes of comparison, the estimates again were based on tests from combined 60°, 70°, and 80° F. samples. *A. sollicitans* represented 26.0, 31.6, and 27.1 percent, while *A. taeniorhynchus* represented 73.9, 68.3, and 72.8 percent. Combined results for all temperatures gave *A. sollicitans,* 28.4 percent and *A. taeniorhynchus,* 71.6 percent. Comparison between these values and those obtained from the identified first instar larvae indicate that *A. sollicitans* was favored by the rearing procedure used.

Of the 8475 adults which emerged, 25.9 percent were *A. sollicitans* and 74.1 percent were *A. taeniorhynchus.* Males exceeded the females in both species by less than 1 percent.

Although the field area selected for sampling was uniform in elevation, plant growth and composition, the viable egg populations in the 0.2 sq. ft. sod samples varied from 14 to 1444 eggs per sample, with a mean of 283 eggs per sample, and a standard deviation of 229 eggs per sample. The samples grouped by population sizes were distributed as follows: 0 to 100 eggs—19 samples; 100 to 200 eggs—26 samples; 200 to 300 eggs—25 samples; 300 to 400 eggs—16 samples; 400 to 500 eggs —8 samples; 500 to 600 eggs—5 samples; 600 to 700 eggs—5 samples; 1 sample each in the 800 to 900 and the 900 to 1000 groups; and 2 samples having over 1000 eggs. There was no evidence of any stratification in the areal distribution of the populations listed.

Some study was made to determine progressive changes in the field area with an advancing season. A second series of 40 samples, taken from the area on February 24, 1956, were held for 10 days at 80° F. and 70 percent relative humidity. When flooded for 24 hours in groups of 10 samples each the average hatches were 108, 212, 115, and 164 larvae per sample with a mean of 150 larvae per sample. A third series of 48 samples taken on March 22,

1956, were flooded in three groups of 16 samples each. Total average hatches per group were 152, 97, and 152 per sample, or a mean of 133 larvae per sample. A fourth series of 48 sod samples taken on April 19, 1956, were flooded in groups of 16 samples each. The average hatch per sample in each group was 23, 24, and 27 larvae, or a mean of 25 larvae per sample. A fifth series of 32 samples was taken on May 29, 1956, and yielded a mean of 13 larvae per sample. The last series, 32 samples, was collected from the field area on June 29, 1956, and gave a mean of only 2 larvae per sample. This progressive decrease in the numbers of larvae from the samples as the season advanced was due largely to natural flooding of the area by the spring tides and heavy rains. There was little apparent replacement of the eggs in this particular area by the population produced. In view of the studies with sod samples held over periods of 1 to 4 months (Bidlingmayer and Schoof, 1956), there was a gradual loss in viable eggs during January-May with marked loss during late June. The periodic flooding, as well as a loss in viable eggs, may account for the progressive seasonal decrease in egg hatch shown in the present study.

Summary. Results from flooding sod samples of *Distichlis spicata* taken from an area of salt marsh having uniform elevation and plant growth show that the estimates of the production potential of *Aedes sollicitans* and *A. taeniorhynchus* may be influenced by the following factors: (a) temperature conditions during a preflood period; (b) counts and identification based on 1st instar larvae, 4th instar larvae, or on emerging adults; (c) a wide range in the numbers of eggs per sample from a relatively small area; and (d) the season of the year at which samples are taken from the field.

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CDC COURSES IN INSECT AND MOSQUITO CONTROL IN FY 1959

The Insect and Rodent Control Training Section of the Communicable Disease Center, Public Health Service, Atlanta, Georgia, is holding courses during the fiscal year 1959, which may be of interest to readers of *Mosquito News*.

Insect Control	September 15–26, 1958
Mosquito Control	November 3–7, 1958
Biology and Identification of Arthropods of Public Health Importance	January 12–23, 1959
Epidemiology and Control of Vector-Borne Diseases	February 16–20, 1959
Insect and Rodent Control	June 1–12, 1959

There is no charge for this training in any of the courses, but persons attending should make their own arrangements for travel and living accommodations. Preference will be given to interested personnel from State and local health departments, the Public Health Service, members of the Armed Forces, and mosquito abatement districts. Additional information about these courses will be found in the "CDC Training Program Bulletin" which may be seen in State and local health departments.

Applications should be made through the sponsoring agency to Chief, Training Branch, Communicable Disease Center, Public Health Service, Department of Health, Education, and Welfare, 50 Seventh Street, N. E., Atlanta 23, Georgia.

A SIMPLE INSECTARY ARTIFICIAL LIGHT CONTROLLER [1]

H. W. FOWLER, JR., W. P. MURDOCH, H. R. BULLOCK, W. H. PARKER AND H. D. BAUMGARDNER

For experimentation and routine maintenance of established mosquito colonies it is often necessary to have an artificial lighting device in the insectary. Some colonized mosquito species, e.g., *Culex tritaeniorhynchus* Giles in Japan, require special lighting conditions during specific periods of the year. The colony of *C. tritaeniorhynchus* maintained by the 406th M.G.L., requires at least 12½ hours daily of natural or artificial light. At this latitude natural light (sunrise-sunset) falls below 12½ hours the latter part of September to the middle of April (1) and during this time it is necessary to supplement the natural light in the insectary with artificial light.

In 1956 an artificial light schedule was instituted in the 406th M.G.L. insectary (2), which simulated dawn and dusk light intensities recorded in the insectary during July and August. It consisted of a dawn period of 1 hour, a day period of 12½ hours, a dusk period of 1½ hours and a night period of 9 hours. Artificial light was manually regulated with a rheostat-controlled lamp in a manner similar to that described by Brennan and Harwood (3). This technique adequately simulated the dawn and dusk photoperiods required by the colony of *C. tritaeniorhynchus* but had the disadvantage of manual operation and necessarily required several hours of extra duty daily for laboratory personnel.

The artificial light controller (Figure 1) was designed to operate on a 24-hour cycle with two 3-hour periods of illumination. These periods simulate dawn and dusk photoperiods and are automatically controlled. The cycle starts at zero light intensity for the simulated dawn period and steadily increases in light intensity until normal daylight occurs. For the simulated dusk period the controller starts at maximum light intensity and steadily decreases to zero light intensity.

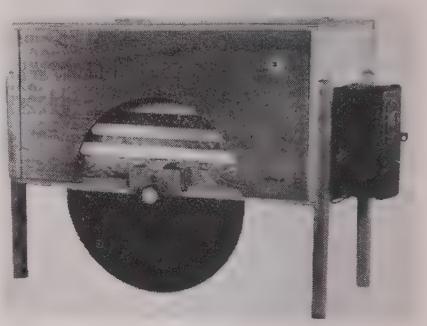

FIG. 1.—Artificial Light Controller.

Wiring and construction details are shown in Figure 2. The unit consists of a rectangular box 10″ wide, 12½″ high, and 23½″ long, constructed from ⅝″ plywood which stands 20½″ high with its four supporting legs. The semicircular face plate opening is 13″ in diameter, and the face plate shield is ⅛″ black bakelite 14″ in diameter. The face plate drive is composed of a model #301 Paragon timer modified by replacing the stock 3.5 rpm motor with a 15 rpm synchronous motor. This modification was necessary to change the original 24-hour cycle to the desired 6-hour cycle for the periods of illumination. The face plate shield is mounted on the drive shaft of the modified timer gear box. Illumination is provided by four 18″, 15 watt, 110 volt AC fluorescent tubes with two reflectors, 13″ x 22½″ and 10″ x 22½″, of machine burnished sheet aluminum which are hinged together to facilitate installation. A model #305 M.B. Paragon timer is used for the automatic time control.

[1] Contribution of the Department of Entomology, 406th Medical General Laboratory, APO 343, San Francisco, California.

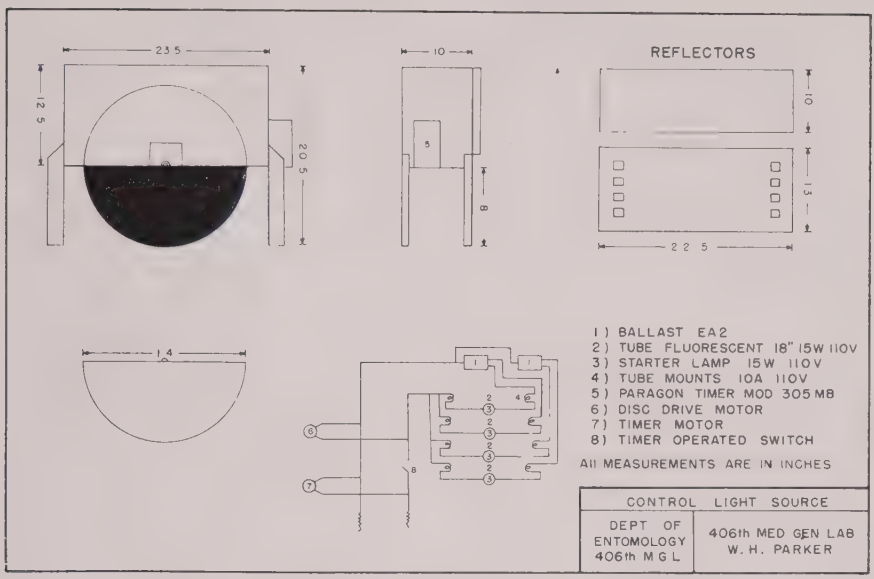

FIG. 2.—Diagram of Artificial Light Controller.

The controller is practically noiseless and does not interfere with mosquito mating activity. It was constructed from salvage parts and the total cost of assembling the unit was considerably less than 50 dollars.

SUMMARY. A simple insectary artificial light controller used to provide the special lighting conditions in the insectary required by a colony of *Culex tritaeniorhynchus* is described. It can easily be constructed from salvage materials found in most laboratories. The controller is designed to operate on a 24-hour cycle with two 3-hour periods of illumination. These periods simulate dawn and dusk photoperiods and are automatically controlled. The controller gives dependable service and eliminates the requirement for laboratory personnel to operate an artificial light schedule.

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MASSACHUSETTS COMMISSION LOOKING FOR SUPERINTENDENT

The Bristol Co. Mosquito Control Project (Massachusetts) is looking for a Superintendent to head their program, which is just getting under way. Starting pay is $6000 per year and increases to around $8000. Interested persons should write to Curtis Peckham, Chairman, 190 South Walker Street, Taunton, Mass.

PAPERS AND PROCEEDINGS OF THE 14th ANNUAL MEETING

OF THE

AMERICAN MOSQUITO CONTROL ASSOCIATION

HELD JOINTLY WITH THE VIRGINIA MOSQUITO CONTROL ASSOCIATION, UNDER THE SPONSORSHIP OF THE A.M.C.A. SOUTHEAST CENTRAL REGION, WASHINGTON, D. C., FEBRUARY 23–26, 1958

PART II

INTERNATIONAL COURSE IN MALARIA ERADICATION TECHNIQUES

HARRY D. PRATT [1] AND DONALD R. JOHNSON [2]

Mosquito control workers everywhere were undoubtedly surprised and pleased to read this statement in President Eisenhower's "State of the Union" message to Congress in January 1958: "We now have it within our power to eradicate from the face of the earth that age-old scourge of mankind: malaria." In the 60 years since the discovery that this disease was transmitted by mosquitoes of the genus *Anopheles,* public health workers throughout the world have dreamed periodically about wiping out malaria, with new drugs such as primaquin and chloroquine, or with new insecticides like DDT and dieldrin. The initial impetus to the present program for malaria eradication throughout the world began in earnest with the campaign that eradicated the African malarial mosquito (*Anopheles gambiae*) from northeastern Brazil in 1940 (Soper and Wilson, 1943) and received strong support in the late 1940's as other countries in this hemisphere such as Puerto Rico, United States, Venezuela, and Chile demonstrated great reductions in malaria transmission, chiefly through DDT residual spray programs. The progress toward the goal of complete eradication has been documented by Paul Russell in a series of papers, such as his fine 1957 article entitled "Malaria in the World Today."

A distinguished group of malaria experts from many countries met in Athens, Greece from June 20–28, 1956 and wrote the Sixth Report of the Expert Committee on Malaria of the World Health Organization. This stated clearly that it was now practical to work intensively on a world-wide program of malaria eradication (completely wiping out the disease in the human population by a campaign limited in time) as distinct either from mosquito eradication (as in the *Aedes aegypti* eradication in the New World) or conventional malaria control (keeping the disease at the lowest possible level but with continuing budgets over an indefinite number of years). This Sixth Report recommended that (1) the world malaria eradication program should be accelerated immediately because an increasing number of important malaria mosquitoes were showing significant resistance to insecticides, and (2) that training courses of two to three months duration be held for all professional people working on this campaign.

[1] Scientist Director, Training Branch, Communicable Disease Center, Public Health Service, Department of Health, Education and Welfare, Atlanta, Ga.

[2] Senior Sanitarian, Public Health Service, detailed to Public Health Division, International Cooperation Administration, Washington, D. C.

The present world-wide malaria eradication program, supported by the International Cooperation Administration, U. S. Public Health Service, World Health Organization, Pan American Sanitary Bureau, United Nations Children's Fund and other organizations, requires far more trained malaria specialists than presently are available. Formerly, a large well organized group of such personnel was available in the United States, but as a result of the programs which have almost eradicated malaria in this country, these entomologists, parasitologists, physicians, sanitarians and sanitary engineers have become engaged in other pursuits.

The Pan American Sanitary Bureau has supported Spanish language training centers in malaria eradication techniques in Mexico and Venezuela, but a similar course in the English language has not been held in the Western Hemisphere. For this reason, the Pan American Sanitary Bureau sponsored as a semi-emergency measure a course for urgently-needed technical personnel from October 14–December 21, 1957. The first eleven weeks were held in Guatemala City, and the last week was spent in El Salvador.

This course, under the directorship of Dr. Firmino de Oliveira Lima, was staffed almost entirely by visiting lecturers who were staff members of the Pan American Sanitary Bureau, U. S. Public Health Service, International Cooperation Administration, United Nations Children's Fund and other organizations. The group from the United States included many people who are members of the American Mosquito Control Association: L. L. Williams, Donald Pletsch, Patrick Owens, George Bevier, Lawrence Hall, Donald R. Johnson, and Harry D. Pratt, long associated with malaria programs. The course was designed primarily for physicians, entomologists and sanitary engineers, but was open also to sanitary inspectors. The twelve weeks were devoted to all phases of malaria eradication: entomology, statistics, parasitology, epidemiology, public health education, chemotherapy, public health administration, vehicle management and maintenance, engineering and spraying operations. Classroom lectures, laboratory assignments and actual field operations gave all participants a well rounded program of activity. Engineers studied malaria parasites, physicians identified anopheline mosquitoes, and entomologists became conversant with chemotherapy. All weighed and mixed insecticides and sprayed houses until thoroughly familiar with techniques used.

The thirty "students" came from sixteen different countries and territories of every region and continent of the world: Argentina, Australia, British Honduras, Colombia, Ethiopia, Grenada, Haiti, India, Italy, Jamaica, Mexico, Philippines, Saint Lucia, Trinidad, West Germany, and the United States. They included fellow members of this organization such as Russell Fontaine, Carlton D. Gilkes, Pantelis Milous, T. A. Omardeen, and M. Sta. Maria. All have since gone on to other countries where they now are actively engaged in a common effort to eradicate malaria.

The Guatemala-El Salvador course was only the first of a series of English language courses which will continue at least through 1961. The training center is being reestablished, under the joint auspices of Pan American Sanitary Bureau and International Cooperation Administration, in Kingston, Jamaica. The first course for senior officials was scheduled for May 19 to August 5, 1958. A separate shorter course for sanitarians was scheduled for August 4–September 27. A second course for senior officials will be presented from September 15–December 6, 1958. The resident staff for this center will include Walter C. Earle, M.D. as Director, Dr. Paul L. Rice as Associate Director, and several other persons experienced in malaria eradication activities.

This staff will be augmented by visiting lecturers from the various agencies mentioned above. In addition to the regular courses, special seminars and study sessions are planned as may be required.

It is anticipated that approximately twenty persons can be accommodated per course. The students will be selected by International Cooperation Administration, World Health Organization and Pan American Sanitary Bureau. Employees engaged in antimalaria work of these organizations, as well as key personnel of national malaria programs are eligible to attend.

The amazing reduction in malaria in the past fifteen years in the Western Hemisphere and in many other countries such as Italy, India, and the Philippines, has raised hopes that this disease may be wiped out completely by a concerted campaign directed in each country by a team of well-trained supervisory personnel. The World Health Organization, International Cooperation Administration, Pan American Sanitary Bureau, United Nations Children's Fund, and cooperating agencies are aiming at total eradication of malaria throughout the world in five to ten years with the exception of residual foci in inaccessible areas such as portions of tropical Africa and the upper Amazon basin.

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MAINTENANCE EQUIPMENT USED ON MARYLAND SALT MARSHES, INCLUDING A NEW DITCHER

E. ELWOOD LYNCH
Maryland State Board of Agriculture, University of Maryland, Salisbury, Maryland

Within the tidewater region of Maryland there are around 300,000 acres of marsh, with a large percentage of this vast acreage capable of producing salt-marsh mosquitoes, whenever proper conditions prevail. In the early thirties two CCC companies were engaged in mosquito work in Worcester County, but during the interval of time they were engaged in this work only fifteen or twenty thousand acres of salt marsh were ditched. In the last twenty or so years, no maintenance work has been done to the ditches constructed by the CCC forces, nor has there been any mosquito work of importance accomplished elsewhere in the state during this interval of time.

In Maryland, a new mosquito program was made effective July 1, 1956 with funds available for both temporary and permanent work. The portion of the law relating to permanent work stipulates that work shall be undertaken only upon the condition that the municipality or special taxing area involved shall agree to defray at least 25 percent of the total cost of such work.

In order to set up an economical maintenance or ditching program for the various interested groups, it has been necessary to rely principally upon machine work, because the grade of labor obtainable for this purpose is generally poor, and if used at today's rates the cost would be prohibitive. In order for us to make any real progress in the next few years, on the vast acreage involved, we would have to rely largely on good, efficient machinery.

When our program was initiated in 1956 the backhoe and scavel combination on an Oliver tractor was a popular machine among New Jersey mosquito units. This type of equipment was developed both for digging new ditches and maintaining existing ditches.

After investigating many types and forms of machinery that could be converted to marsh usage, it was decided the backhoe and scavel unit was the most practical for our use considering cost and availability of such a unit. At the same time we had given considerable thought towards the purchase of a bucket type excavator such as the Oliver Universal Trencher, Model *3A-48;* but there were engineering problems involved that could not be solved at the moment, the main one being that the track centers were 48 inches apart instead of the customary 72 inches. With the bucket or chain type excavator the rate of work is more uniform than that of the backhoe; however, the bucket or chain type unit has its limitations in connection with mosquito work. Its use is limited almost entirely to small ditch maintenance and cutting new laterals, whereas the backhoe is capable of doing the same type of work, and in addition, the units in our possession are designed to dig either astride or off-side the ditch. This feature permits cleaning of wide ditches or natural streams up to twenty feet in width. They are also useful in construction work, and handy for building or repairing dykes.

The backhoe usually does a good job under normal conditions requiring very little labor for follow-up work. It is not as efficient as a bucket or chain excavator on narrow ditches, because so many movements of the lever system are necessary before a digging cycle can be completed. The average operator can clean or dig up to 1500 feet of 14″ to 24″ width ditch in an eight-hour day.

We now have two backhoe-scavel units on Oliver OC-3 tractors. Each unit is equipped with a Henry C-10 H hydraulic backhoe on the rear and a Ware Loader mechanism on the front to carry the scavel unit. We specified the Henry backhoe because it had many features which permitted conversion to marsh usage. The backhoe-scavel unit has some improvements over those which we investigated. These units are so designed that the parts and accessories are interchangeable from one tractor to the other. The backhoe stabilizer unit with hydraulic extension pads has a clearance of approximately 18″ from the marsh, this being very important in traveling across marsh terrain, stumps, etc. This clearance is also important because it prevents the tractor from being bogged down in many cases. To cope with the extra load on the knee action system, a transverse spring was installed to carry the overload. The tracks are on a 72″ center rather than on a 68″ center to permit the use of 36″ gum wood grouser extensions.

Since the tractor is equipped with a backhoe attachment for the rear and a scavel unit for the front, both implements require the use of a counterweight. This counterweight is interchangeable from front to rear by having fittings common to both usages. It is held in place by three pins. In either case the operator can mount it without any assistance by using a special hydraulic cylinder to lift it in position at the rear of the tractor, while the front arms lower sufficiently for attaching it at the front. The counterweight is a compact unit weighing about 600 lbs. so that when mounted it does not obstruct the operator's view.

The backhoe unit is designed with the parallel circuit control valve, with free flow to permit simultaneous operation of any two or more hydraulic cylinders at the same time. The hydraulic pump has sufficient capacity to cope with this design. This feature adds considerably to the efficiency of its digging operation.

These tractors are equipped with Trasco reduction gears permitting 10 forward speeds and 6 reverse. This feature adds approximately $200 to the cost of the unit, but with this installation it has so many

FIG. 1.—Pow-R-Ditcher in action.
FIG. 2.—View of Pow-R-Ditcher buckets.

advantages over the standard gear system that the extra cost is not prohibitive. It gives the tractor more power when needed, operates the unit smoothly under almost any condition, and prevents it from being bogged down in many instances, due to its steady power. The motor does not stall easily when working at peak performance under boggy conditions, affording it an easy out process which is important. This gear reduction system saves clutches, axles, and gears. In many instances we have been able to creep out of boggy areas where the regular gears would probably have caused the engine to stall out, thereby permitting the machine to sink each time the engine failed.

This unit, fully equipped with counterweight and backhoe, weighs approximately 8300 pounds. When equipped with 36″ wooden pads 4½″ wide the ground pressure is around 2.3 pounds per square inch. On the basis of our specifications this unit was developed, equipped, and supplied by the Paving Supply & Equipment Company in Washington, D. C.

Last summer our State Entomologist, Dr. George Langford, while attending a conference, came in contact with a representative of the Vermeer Company, Pella, Iowa, who thought their self-propelled Pow-R-Ditcher 524-T might be useful in our ditching and maintenance operations. As a result of this contact the company sent their engineers to study our marshes. Subsequently, they assembled a special self-propelled ditcher which they thought would meet our requirements. (Fig. 1). Upon testing it under normal marsh conditions, it demonstrated its usefulness in constructing new 14″ ditches at the rate of around 300 to 600 feet per hour. It also, to our amazement, cleans out old ditches under average conditions.

This machine has no buckets to clog up. It is a chain digging type excavator with side cutters which have automatic cleaning devices at the top of the excavator frame (Fig. 2). This cleaning device removes trash, or roots as the case may be, allowing undisturbed operation under normal conditions. The tracks were widened to 18″ to reduce the ground pressure. It weighs approximately 6200 pounds with seven feet of track on the ground on each side giving resulting ground pressure of approximately 2.1 pounds per square inch. To meet our specifications the track gauge (center to center track) was increased to 72″. This permitted the unit to go astride the ditch giving full traction for the 18″ width track. We also requested the conveyor belt be geared so that the sod could be discharged from one side of the ditch to the other. This alternate sod breaking allows side drainage into the ditches, and permits shifting of the sod when crossing another ditch, or wherever sod breaking is necessary to facilitate side drainage.

The ditcher has a VG4D-V36 H.P. Wisconsin Air-Cooled Engine, 6 volt electric system, electric starter, hydraulic track clutch and brake control, two way conveyor, double digging chain with two sets of idle sprockets on top and bottom of boom, and maximum digging depth of 4′–6″. It cuts 14″ to 24″ width ditches but is presently equipped only with 14″ cutters. The digging range is 1 to 18 feet per minute and the transport speed is three miles per hour. The total width of the unit is eight feet allowing transportation over the highway without special permit. It has a five speed dual transmission for digging and transport purposes including one reverse speed. The cost delivered to us in December, 1957 was $6,750.00.

It is quite evident there may be some changes necessary, as time goes on, and we cannot fully recommend it for all salt marsh uses. Possibly at a later date, when we have had more time to discover its limitations, we can specify the conditions under which it can be utilized. When we compare the ditching rate of 300 to 600 ft. per hour against possibly that of the backhoe at 100 to 175 ft. per hour, or that by hand from 15 to 25 per man hour then we can appreciate its value under certain conditions when the cost is only $6,750.00.

OBSERVATIONS ON THREE SPECIES OF *CHAOBORUS* LICHT. (DIPTERA: CULICIDAE) AT CHURCHILL, MANITOBA [1]

H. G. JAMES AND B. C. SMITH [2]

Mosquitoes of the genus *Aedes* Mg. breed in enormous numbers in the subarctic regions of Canada, and their control in establishments of the far north has been the subject of considerable research. Though much is known about the biology of the pest species, comparatively little is known about their natural enemies, including culicid predators of the genus *Chaoborus* Licht.

Contributions to the biology of nearctic species of *Chaoborus* by various workers were summarized by Johannsen (1934) and Matheson (1944). More recently, Jenkins and Knight (1950), Haufe (1952), and Sailer and Lienk (1954) reported on the behavior and ecology of some of the northern species.

The present paper contains information obtained at Churchill, Manitoba from 1949 to 1952 on the habits and seasonal histories of *Chaoborus nyblaei* (Zett.), *Chaoborus americanus* (Joh.), and *Chaoborus borealis* Cook (Cook, 1956).

METHODS: AREA. Larvae of *Chaoborus* spp. were collected from Churchill southeast to Farnworth Lake and south on both sides of the C.N.R. line to Goose River (Figure 1). According to Haliday (1937), this area is on the border between the northern Boreal forest and the arctic barrens, and includes both types of terrain. The severe climate stunts tree growth, and the low elevation and the presence of permafrost permit only superficial drainage. On the tundra and in the forest, melting snow and ice during May and June form additional pools, in which culicids breed.

Larval development of the three species was determined from spring and summer collections. In addition, *C. nyblaei* larvae were studied in a selected forest pool near Goose River in 1950. Larvae and associated arthropods were collected with a suction-type sampler that consisted essentially of a watertight steel cylinder attached to a length of brass pipe. To operate the sampler, the cylinder was submerged and its bottom opened by a lever on the handle. Water containing aquatic organisms replaced the air in the cylinder, and was trapped when pressure on the lever was released. A sample was taken from four representative parts of the pool at 10 a.m. at intervals of three days from June 17 to August 16.

In 1951, a tent trap somewhat resembling the pyramidal cage of Lindquist and Deonier (1942) was used to catch adults of *C. nyblaei* emerging from a deep pool (Figure 2). The base of this trap was provided with sharpened stakes at the corners so that it could be partly submerged and securely anchored to the bottom of the pool. The sides were of translucent plastic, and the top section was ventilated by screened windows at each side. The cage, which covered an area of one square yard, was set up in a pool on July 6, when 31 percent of the larvae had pupated, and was examined daily until July 20 and subsequently every second day. *C. nyblaei* adults were directed toward the trap jar by placing a cover of black denim over the top section and gently tapping the latter. Pool temperatures were recorded with a maximum-

[1] Contribution No. 3809, Entomology Division, Science Service, Department of Agriculture, Ottawa, Canada. The results shown herein were obtained by the Entomology Division in studies on the biology and control of biting flies conducted on behalf of the Defence Research Board, Canada Department of National Defence, and with the co-operation of that organization and other agencies.

[2] Entomologist and Assistant Entomologist, Entomology Laboratory, Belleville, Ontario.

minimum thermometer three inches below the surface outside the cage.

Emerging adults of *C. borealis* were trapped by means of a plastic screen cage with a removable top (James, 1957). In 1951, this cage was placed over part of a shallow pool in open forest near Farnworth Lake on June 28, when approximately 35 percent of the larvae had pupated (Figure 3). Emerged adults were reared in deep Melrose boxes in a laboratory at Fort Churchill, and fed split raisins and a 10 percent solution of sucrose on cotton wads.

The feeding habits of *C. borealis* were studied in an insectary. In the first test, mature larvae were reared individually in eight-ounce glass jars containing strained pond water, and each was supplied daily with 10 *Aedes* larvae or with 10 adult *Daphnia* spp. In the second test, the predators were each given 10 or 20 *Aedes* larvae and then reared for five days. In the third, the predators were kept without food for one day and then each was confined with 10 *Aedes* larvae for 24 hours.

Larval Habitats. *Chaoborus borealis*. This species, which appears to be closely related to the European species *Chaoborus crystallinus* (De G.), has so far been found only in Canada, at points along the northern fringe of the Boreal forest (Cook, 1956). At Churchill the mature larvae, previously mis-identified as of *Chaoborus flavicans* (Mg.) (James, 1953), were first collected from shallow, open forest pools in association with *Aedes communis* (De G.) and *Aedes punctor* (Kby.). These pools were 6 to 14 inches deep and were situated in a depression among scattered black spruces, tamaracks, and dwarf willows near Farnworth Lake. They were margined with sedges and reindeer moss, and had an average pH of 5.0. Larvae were also present in the shallow water of deeper, permanent pools. In general, this species was the most common chaoborine of the open forest.

Larvae were found also in steep-banked pools in the vicinity of Warkworth Creek and Goose River. In the latter area they were exceptionally numerous in a narrow,

Fig. 2.—Pyramidal tent trap in a forest pool near Goose River, in which adults of *Chaoborus nyblaei* emerged.

Fig. 3.—Plastic screen cage used in a pool near Farnworth Lake to trap adults of *Chaoborus borealis*.

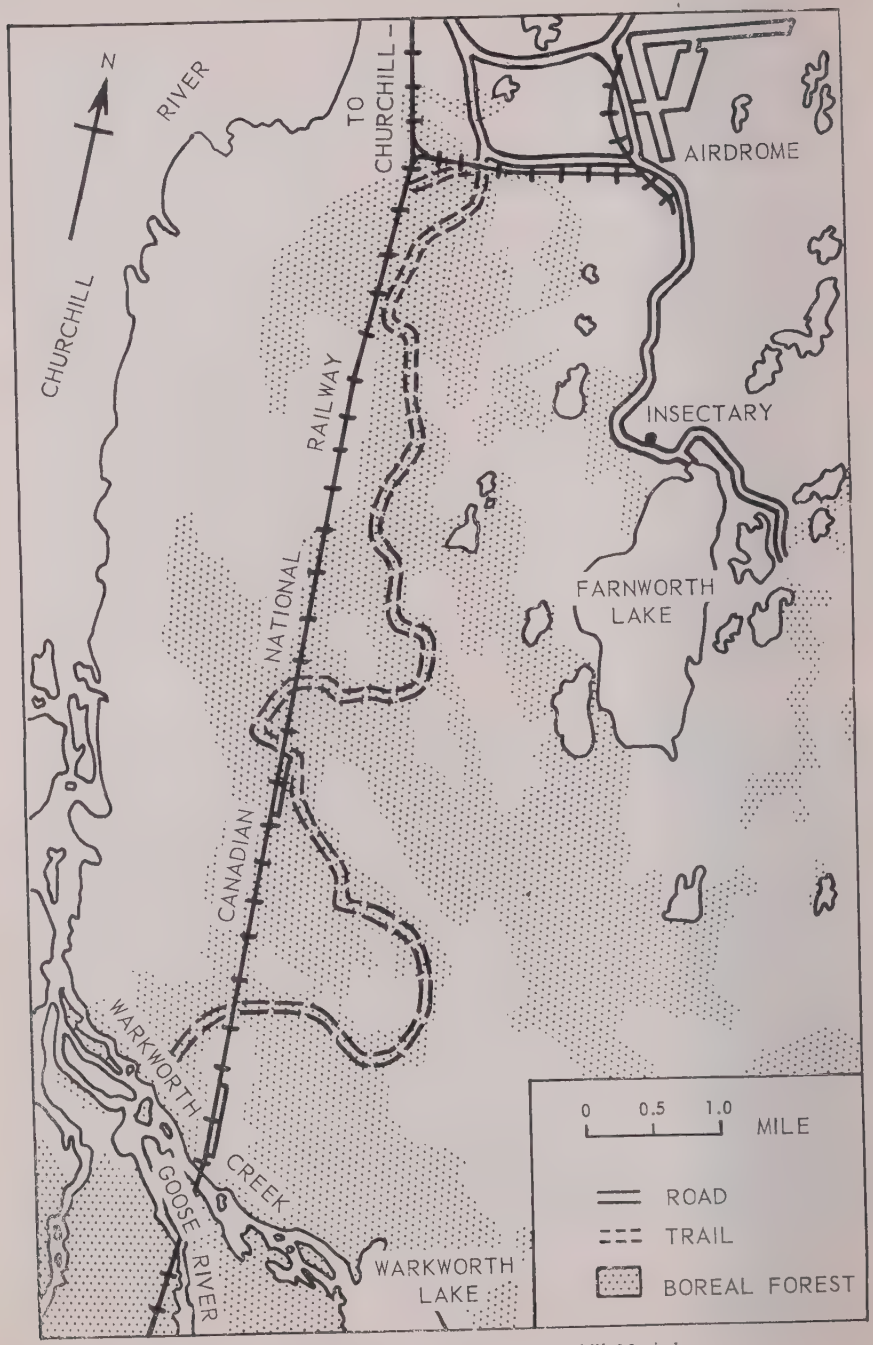

FIG. 1.—Principal sites investigated near Churchill, Manitoba.

sinuous pool containing larvae of *A. communis* and *A. punctor*. This pool, approximately 25 feet long, 3 feet wide, and 18 inches deep, had a muck bottom and was bordered mainly by scrub willow and emergent sedges. No larvae of *C. borealis* were found in tundra-meadow pools.

Chaoborus nyblaei. Both Matheson (1944) and Cook (1956) reported that this species is widely distributed in North America, particularly in arctic and subarctic regions. Larvae from Churchill were collected from rather deep forest pools near Goose River. The pool chosen for studying the larvae was approximately 16 feet long by 6 feet wide, and its greatest depth on June 16 was 3¼ feet. The bottom consisted of a three-inch layer of black muck, rich in hydrogen sulphide, which overlay compact clay and some gravel. Though the pool was shallow at each end, much of it was shaded by the south bank that rose abruptly above the deeper water to a height of four feet. The pool was also shaded by dwarf birches and willows.

Emerging adults were trapped from a somewhat smaller forest pool of an average depth in July of only 10 inches. This pool was well shaded, however, and temperatures three inches below the surface ranged from 12.4° to 17.0° C. from July 10 to August 23. Associated with the predator in this pool were *Aedes cinereus* Mg., *Aedes excrucians* (Walk.), *Aedes implicatus* Vock. (*A. impiger* of American authors), and *Aedes pionips* Dyar.

Chaoborus americanus. Of the three species of *Chaoborus* found at Churchill, *C. americanus* was encountered least frequently. Larvae were abundant, however, in one open forest pool near the C.N.R. tracks at Mile 503. This was a long, narrow pool, five to seven feet wide and up to two feet deep, with a five-inch layer of black muck overlying the frozen soil beneath. Few mosquito larvae were present. Additional larvae of the predator were collected near Goose River from forest pools that also contained *C. borealis*.

Seasonal History. *Chaoborus borealis*. One generation was produced annually. The mature, overwintering larvae usually resumed development early in June, after the variable arrival of the spring thaw, but as a rule the larvae were not found until after the eggs of *Aedes* spp. had hatched. In 1950, the predators were not found on June 1 in pools containing first-instar *Aedes* larvae and none were obtained from samples of soil and moss dredged from these pools. This suggests that the larvae remained in the frozen mud until the level of the permafrost receded. Mature larvae were abundant in pools near Farnworth Lake on June 6, and on June 11 they aggregated in some forest pools to the extent of three to four per litre. In general, larvae appeared later in the forest pools than in those of the open forest.

Pupation occurred in June or July, depending on the weather and on the site and type of pool. Pupae were found in transitional forest pools from June 3 to July 8 and in forest pools during early July. In 1951, pupae observed in an open forest pool on June 28 remained in this stage as long as 10 days.

Emergence probably occurs during late June and July. Of 16 adults trapped in the plastic, screen cage near Farnworth Lake, males emerged from June 30 to July 6 and females from July 1 to July 16, when the last adults of *A. communis* and *A. punctor* emerged in the same cage. In addition to 215 *Aedes* spp. adults, 298 other adult Nematocera were taken in the trap, including the craneflies *Limnophila poetica* O.S., *Prionocera proxima* Lack, and *P. turcica* (F.), and a midge, *Pentaneura* sp.

Presumably eggs are deposited in the pools during July. Though oviposition was not observed, several fertile egg rafts were obtained in the laboratory during July 21 to 25 from caged females. The rafts, each consisting of 80 to 160 eggs, were laid in a gelatinous support on the surface of water in watch glasses. In one raft observed, the eggs darkened after two days and on the third day most of them hatched. Variations in the lengths of

young larvae in different pools during July indicated that some eggs are deposited much earlier than others. Mature larvae were found in late August.

Chaoborus nyblaei. There was one generation a year. The presence of late-instar as well as newly-hatched larvae in the earliest spring collections indicated that the winter was passed either as a larva or in the egg stage. Regular sampling of a selected pool at Goose River in 1950 showed that though mature and early-instar larvae were present in the first samples on June 17, the number per sample later increased and reached a peak on June 26 apparently as more larvae were released from the thawing pool bottom (Figure 4). Later, as they began to pupate, fewer larvae were taken, though this did not account fully for the reduction. Toward the end of July, however, the numbers increased again as young larvae of the new generation appeared in the samples. These small larvae were distinct from those of *C. americanus* and *C. borealis;* larvae of *C. nyblaei* were collected also from an adjacent pool. The pH of the selected pool, from June 17 to August 4, ranged from 7.0 to 8.3 with a mean of 7.6. During this period the higher levels of pH were observed when the larvae of *C. nyblaei* and *Aedes* spp. pupated and also when *Daphnia* spp. became abundant.

Adults emerged from early July until mid-August, depending on the season and the site and depth of the breeding pool. Twinn *et al.* (1948) reported *C. nyblaei* from a male swarm at Churchill on July

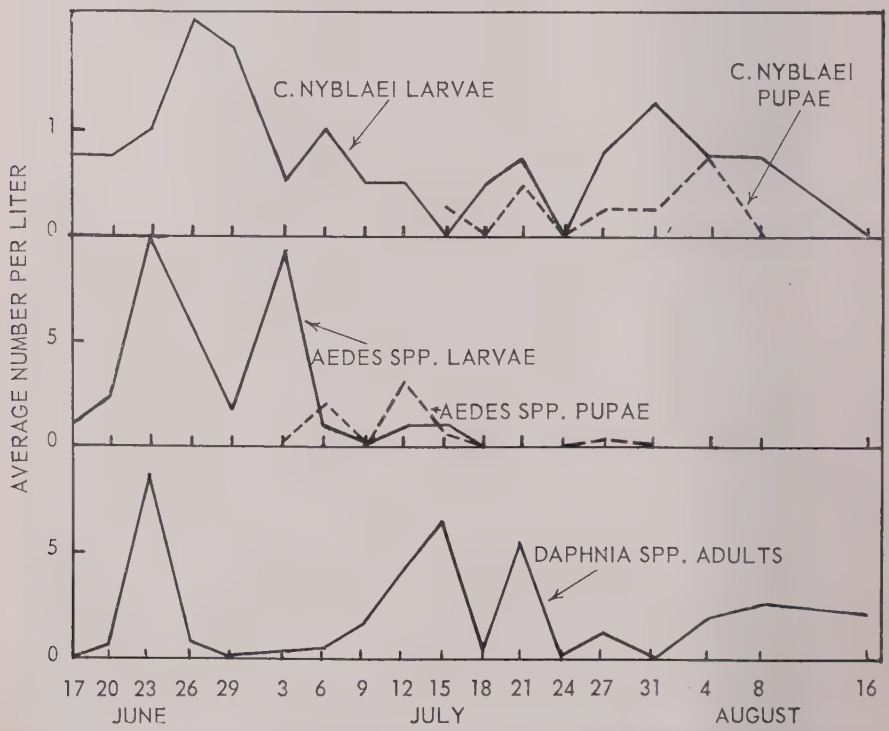

FIG. 4.—Relative abundance of *Chaoborus nyblaei, Aedes* spp., and *Daphnia* spp. in a forest pool near Goose River, June 17 to August 16, 1950.

24, and in 1950 the junior author observed adults emerge in an insectary from July 31 to August 8. A total of 43 males and 46 females were taken in a tent trap in 1951. Emergence was marked by two peaks, the first on July 11, consisting of males only, and the second on July 30, consisting of males and females (Figure 5). In a deeper, and more shaded forest pool, *C. nyblaei* emerged in a plastic screen cage from August 3 to August 17. It is evident that larvae that mature late in such pools greatly extend the emergence period of this species.

Eggs laid by the early-emerging females hatched into larvae that completed their growth by the end of the summer; presumably the later eggs either produced young, overwintering larvae, or went into diapause. In 1951, caged females deposited several egg rafts in beakers of pond water during August 14 to 17, but none of these eggs hatched in late summer.

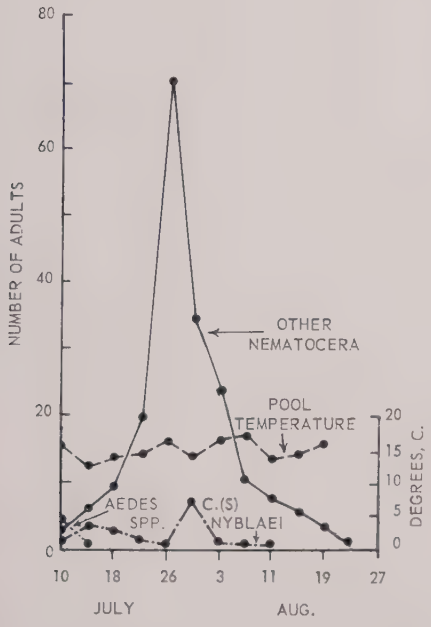

FIG. 5.—Average numbers of *Chaoborus nyblaei* and other Nematocera emerging during four days in a pyramidal tent trap near Goose River, 1951.

Chaoborus americanus (Joh.). This species had one generation a year and usually overwintered as a mature larva. Fourth-instar larvae and some pupae were found in forest pools near Warkworth Creek soon after the spring break-up in 1949. Similar larvae were collected in the forest pools at the end of August. At Great Whale River, Quebec, Jenkins and Knight (1950) found pupae on June 24 and observed male swarms from June 28 to July 3. In the Churchill area, pupae were taken on June 18 and July 2 from forest pools, all near Warkworth Creek.

FEEDING TESTS. During preliminary feeding tests in 1949, fourth-instar larvae of *C. borealis* destroyed an average of 0.7 (range, 0–1.2) *Aedes* spp. larvae in 24 hours. Further tests in 1950 confirmed that *C. borealis* is a predator of *Aedes* spp. larvae and of *Daphnia* spp., though the latter diet delayed pupation. In the first test, each of eight predators destroyed an average of 0.3 (range, 0.2–0.5) *Aedes* larvae and 0.1 *Daphnia* in 24 hours. In the second, each of eight predators that were confined with 20 *Aedes* larvae killed an average of 0.6 *Aedes* daily; those confined with 10 *Aedes,* 0.3 daily. In the final test, 10 predators each destroyed an average of 0.4 *Aedes* in 24 hours. Approximately eight percent of the *Aedes* larvae in the test lots and controls of the first two experiments died from undetermined causes, but no such losses occurred in the final test. Admittedly, in the pools the rate of predation may be greater or less than that in the experiments, depending on the relative size of the mosquito larvae, their population density, and the presence of other prey. In the pools at Goose River mature larvae of *Chaoborus nyblaei* were observed to capture pupae as well as fourth-instar mosquito larvae. After the mosquitoes had emerged, however, dissections indicated that the predators were feeding on *Daphnia* spp., ostracods, and other crustaceans.

SUMMARY. During a survey of predators of *Aedes* spp. near Churchill, Manitoba, *Chaoborus americanus* (Joh.) and

C. borealis Cook were collected from forest and open forest pools, the latter species in association with *Aedes communis* (De G.) and *A. punctor* (Kby.). *Chaoborus nyblaei* (Zett.), however, was found principally in deep forest pools, some of which contained late-emerging *Aedes* spp.

Each species produces one generation annually and overwinters as a larva, though presumably some of *C. nyblaei* overwinter as eggs. The number of overwintered larvae of *C. nyblaei* taken from a selected pool increased from 0.7 per litre on June 17 to 1.9 on June 26, but then decreased until mid-July as they pupated; as the new generation appeared, the number again increased, reaching a peak toward the end of July. Adults of *C. nyblaei* emerged from early July to mid-August. The development of *C. borealis* and *C. americanus* varied with the weather and the type of pool. In 1951, adults of *C. borealis* emerged from an open-forest pool mainly in July and some laid eggs that hatched in three days. Young larvae also present in the pools in early July matured in late August. *C. americanus* pupated from mid-June to early July and larvae of the new generation matured at the end of the summer.

C. borealis and *C. nyblaei* preyed on *Aedes* spp. Larvae of the former destroyed an average of 0.3 to 0.6 prey daily in insectary tests.

ACKNOWLEDGMENTS. The writers are indebted to Dr. C. R. Twinn, formerly Head, and other officers of the Veterinary and Medical Entomology Unit, Entomology Division, Ottawa, for facilitating this study, and to Mr. G. E. Shewell and Dr. J. R. Vockeroth, Insect Systematics and Biological Control Unit, Entomology Division, Ottawa, for identifying specimens of Diptera. Thanks are due also to Mr. C. Nicholls, Entomology Laboratory, Belleville, who assisted in designing the aquatic insect cages.

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A.M.C.A. members in the North Atlantic and Southeast Central Regions are invited to an informal meeting in Baltimore at the time of the Eastern Branch meetings of the Entomological Society of America, November 24 and 25, 1958. Full information will be furnished later. Make your plans now for a visit to Baltimore.

REACTIONS TO MOSQUITO BITES[1, 2]

ANNE HUDSON,[3] J. A. McKIEL,[4] A. S. WEST[5] AND T. K. R. BOURNS[6]

The clinical reaction to mosquito bites is characteristic; a localized erythematous region around the puncture site, heat, pruritus and possibly some degree of pain. The severity of the reaction varies from person to person and the time elapsing between the bite and the appearance of a skin reaction may vary from a few minutes to 48 hours.

Many theories have been put forward to explain the nature of reactions to insect bites. These have included attempts to attribute the wheal and erythema to mechanical damage, irritation of the skin caused by a specific toxin secreted by the mosquito, and injection of histamine by the insect. Experiments have shown that, while these factors may contribute to the cause, they are not responsible for the type of reaction produced; this appears to be clearly allergic in nature.

From the evidence available, it is apparent that a characteristic sequence of events takes place in all subjects exposed to mosquito bites over a period of time. Evidence for this sequence has seldom been presented by a single subject. It has been compounded from observations on young children and persons with no known history of mosquito bites, from persons known to have been exposed intermittently to a moderate number of mosquito bites, and from persons who have been exposed intensively for long periods of time.

A series of experiments which gave a clear indication that some sequence occurred was carried out by Mellanby in 1946. He selected a group of students who were not known to have had previous exposure to the bites of *Aedes aegypti*. When the experiment was begun, the first (delayed) reactions to the bites appeared 24 hours after they were received. During the subsequent months more bites were received and immediate reactions occurred in addition to the delayed response. Further exposure produced a reduction in the latent period between immediate and delayed reactions until finally the latter disappeared completely. Mellanby suggested that continued exposure would result in no reaction at all.

Heilesen, in 1949, experimented with 10 Danish children aged from 6 months to 3 years. No reaction was given to the first bites received. Four of the children were exposed to repeated bites, and all gradually developed delayed reactions.

These observations, together with many others led McKiel (1955) to extend Mellanby's classifications of reactions from 4 to 5 stages:

Stage	Immediate Reaction	Delayed Reaction
I	—	—
II	—	+
III	+	+
IV	+	—
V	—	—

In the work to be described we have been concerned with confirmation of the allergic nature of reactions to insect bites and with the establishment of a quantitative estimation of the time and number of

[1] Contribution from the Department of Biology, Queen's University, Kingston, Ontario, Canada.
[2] These studies have been supported by the Defence Research Board of Canada and the United States Public Health Service.
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bites necessary to sensitize laboratory rabbits. At the present time attempts are being made to demonstrate circulating antibodies to "bite substance" and to obtain mosquito salivary fluid for analysis.

Man is unreliable as a subject for investigations on the bite reaction, because it is often difficult to obtain an accurate account of past exposure to insects. A laboratory animal with a known history, and one which gives a clear response, is more useful. Rabbits have proven to be more satisfactory than rats, mice or guinea pigs.

Our first attempts to sensitize rabbits were made by exposure to mass-biting by mosquitoes.

1. Clean rabbits were tested with 2 or 3 bites to detect any existing sensitivity.

2. The rabbits were exposed to large numbers of mosquitoes (approximately 5,000) for two hours on successive days for five days.

3. A resting period of 5 to 7 days was allowed for the development of sensitivity.

4. Challenge bites by two mosquitoes were given to detect sensitivity.

As a result of these tests, it was found that when sensitivity developed a wheal appeared within 10–15 minutes and reached a maximum usually within one hour. However, the proportion of rabbits which would become sensitized by this method was unpredictable, and there was no means of determining the course of development of sensitivity in individuals. In some cases it was believed that an animal may have become sensitized and then temporarily desensitized by exposure to large numbers of insects. Other methods were attempted to determine the relation between time of exposure and the number of bites received.

PAIRED BITES ON SUCCESSIVE DAYS

1. Rabbits were given a preliminary test for sensitivity as above.

2. Two bites per day were given daily and the sites observed at hourly periods between one and 24 hours.

Results have shown clearly that the minimum period required for the appearance of small wheals was between 7 and 9 days. Between 10 and 14 days a maximum wheal size was reached, followed on successive days by fluctuating wheal sizes intermediate between the minimum and maximum. The latter condition persisted for 30 days (duration of the experiment). The maximum wheal size was frequently not reached until 12 hours after the bites were given, but this was a highly individual effect.

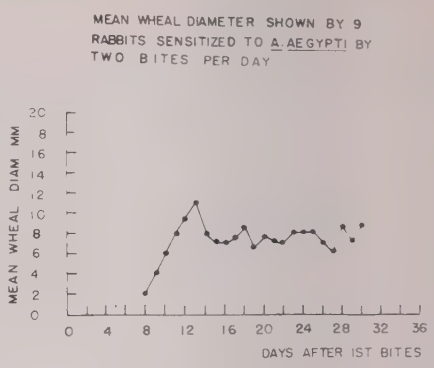

FIG. 1.

In Figure 1 the mean wheal diameter given by 9 rabbits during the experimental period is shown. Figure 2 shows the mean wheal diameter, the range and standard error at the 9th, 13th, 15th and 25th days. Since the standard errors between the 9th and 13th days do not overlap, it is

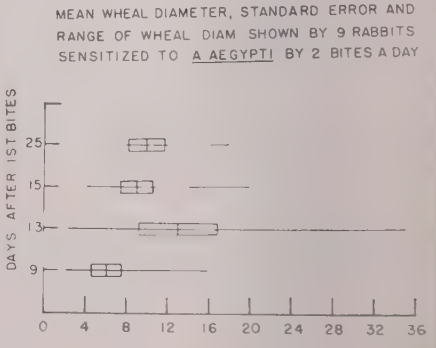
MEAN WHEAL DIAMETER, STANDARD ERROR AND RANGE OF WHEAL DIAM SHOWN BY 9 RABBITS SENSITIZED TO A. AEGYPTI BY 2 BITES A DAY
DAYS AFTER IST BITES
9
13
15
25
0 4 8 12 16 20 24 28 32 36

FIG. 2.

concluded that there is a significant difference in the wheal diameters obtained on these days. Between the 13th and 15th and 13th and 25th days the standard errors do overlap and it is concluded that there is no significant difference between wheal sizes produced after the maximum has been attained.

PAIRED BITES ON ALTERNATE DAYS

The second method decreased the number of bites; two bites per day were given on alternate days. The degree of sensitivity produced was less, although some small reactions were obtained, and it was shown that less than 12 bites over a period of 12 days were required to produce some sensitivity.

The development of the reaction as shown by these experiments supports the theory of its allergic nature.

SPECIFICITY

Attempts have been made to determine the specificity of the reaction to mosquito bites. Rabbits sensitized to *A. aegypti* by various methods were tested with other species of *Aedes,* some *Culex* and some *Anopheles;* challenge bites with the sensitizing species were given prior to each test, and control bites with the sensitizing species were included in all tests. The overall results were inconclusive; examples are shown in Table 1.

Rabbits 11–52, listed in the table, were selected as examples because they gave a good response to challenge bites, and were positive to control bites. They were thought to be near the period of peak sensitivity although this cannot be accurately stated since the methods of sensitization varied and the heterologous tests were performed some days after the last

TABLE 1.—Specificity of Mosquito Bite Reactions in Rabbits

Rabbit No.	Method of sensitization	Result of challenge bites	Results of bites with heterologous species		Control bites with sensitizing species
			Positive	Negative	
	With *Aedes aegypti*				
11	Mass biting	+	*Aedes trichurus* *A. stimulans*	—	+
15	2 bites per day	+	*A. trichurus* *A. punctor* *A. excrucians*	—	+
16	"	+	*A. trichurus* *A. stimulans*	—	+
65	"	+	*A. stimulans* *A. excrucians* *A. vexans*	*Anopheles occidentalis*	+
75	2 bites per day on alternate days	+	*A. vexans* *A. excrucians*	*A. occidentalis*	+
	With *Aedes canadensis*				
52	2 bites per day	+	*A. punctor* *A. stimulans*	*Mansonia perturbans*	+
53	"	±	*Anopheles occidentalis*	*Anopheles quadrimaculatus*	+
			Aedes stimulans	*A. punctipennis* *Aedes aegypti*	

sensitizing bite. Rabbit 53 gave a poor response to challenge bites but was positive to the control. This rabbit had been observed to show a peak sensitivity on the 16th day of the sensitization period and was tested on the 24th consecutive day.

It appears that the degree of sensitivity to heterologous species may be determined by the time during the sensitization period at which the test is made; those rabbits which were at, or close to, the maximum reaction stage gave a greater indication of specificity than those which were tested later during the period of sensitization. This would show agreement with the serological hypothesis that specificity may be lost with increasing duration of sensitization.

ANALYSES OF WHOLE MOSQUITO EXTRACT

Up to the present time most attempts to determine the antigenic factors in mosquito bites have involved the use of whole mosquito extract. A saline extract has been used to sensitize rabbits and has been subjected to certain analytical procedures (McKiel, 1955). Chromatographic fractionation of whole extracts has revealed that the active principle is comprised of at least four components, eluates of which have produced positive reactions in individuals giving strong immediate reactions to mosquito bites.

Calculations of the amount of active material required to produce a bite reaction gave a value of 0.0013 μg of chromatographically purified material. This estimated quantity is probably greater than the amount actually injected by the mosquito.

The use of whole extract obviously complicates any investigation such as this, and we are therefore at the present time devising a method for extracting salivary fluid from the mosquito.

SEROLOGICAL EXPERIMENTS

One of the most perplexing aspects of the reactions to mosquito bites is our inability to demonstrate circulating antibodies in bite-sensitive serum. Precipitin ring tests will give positive results on sera obtained from injected animals; however, this reaction does not involve only the 'bite substance.' It is possible that the amount of antibody present in bite sensitive animals is extremely small and therefore requires a much more sensitive test. Some experiments have been made using the tanned-cell technique of Boyden (1951); further tests have been delayed until the antigenic factors can be obtained either from saliva or from purification from salivary glands.

Attempts have been made to obtain passive transfer of sensitivity (McKiel, 1955 and in the present work); these have been unsuccessful.

SUMMARY

1. Evidence is presented for the occurrence of a definite sequence of events during sensitization of human subjects to mosquito bites.

2. Experiments with different methods of sensitizing rabbits have given information about the relation of time and the number of bites required to produce sensitivity. The results have supported the theory of the allergic nature of the reaction.

3. Chromatographic fractionations of extracts of whole mosquitoes have revealed that the active principle has at least four components.

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THE 1956–1957 STATUS OF *AEDES AEGYPTI* IN THE UNITED STATES

GEORGE R. HAYES, JR. AND MILTON E. TINKER [1]

The vector of dengue and urban yellow fever, the *Aedes aegypti* mosquito, is a widely distributed species in tropical and subtropical regions. In the United States it is common in the southern tier of States from Texas east, but has received little attention from the majority of health workers since the close of World War II because there has been no outbreak of yellow fever in the United States since the 1905 New Orleans epidemic. Since then, the disease has occurred sporadically, with the last case reported in 1924 from Houston, Texas, (USPHS, 1940). Another reason for the lack of interest in the mosquito is that reported cases of dengue have been steadily decreasing since the last serious epidemic in 1934 (USPHS, 1953).

However, during the past nine years there has been an increasing interest in *Ae. aegypti* in the United States because of a northward movement of sylvan yellow fever in Central America; an urban outbreak of yellow fever in Trinidad in 1954 (Soper, 1955); and the possible use of yellow fever virus in biologic warfare. The northward movement of sylvan yellow fever was first noted when the disease reappeared in a section of Panama late in 1948 where it had not been found for 43 years (Elton, 1952). Since then, it has progressed northward to the southern boundary of Mexico (Rodaniche and Galindo, 1957). Although sylvan yellow fever is principally a disease of forest primates transmitted by several species of forest mosquitoes, including *Haemagogus spegazzinii falco* (Shannon *et al.*, 1938) and *Haemagogus equinus* (Rodaniche and Galindo, 1957), a number of human cases and fatalities have occurred.

It is not the possibility of sylvan yellow fever encroaching into the United States that has principally concerned health authorities in this country, although *Haemagogus equinus* has been found as far north as Brownsville, Texas (Trapido and Galindo, 1956). Rather, they are concerned that the virus may be introduced into this country via infected persons, animals, or mosquitoes from areas where sylvan fever is rampant. Once in the country, the virus may become established in the indigenous *Aedes aegypti* population and urban transmission of the disease could recur. This danger of importation has been facilitated by modern transportation which has reduced the travel time between the tropical regions and continental United States to hours.

In 1947, before the spectacular movement of sylvan fever began, the Pan American Sanitary Organization adopted a resolution recommending campaigns for the eradication of *Ae. aegypti* as the best method of preventing epidemics of urban yellow fever. Such campaigns have been instituted in most of the countries of the hemisphere where these mosquitoes exist. A number of the programs already have been brought to a successful conclusion (Severo, 1956). The United States is one of the countries that has not instituted a nationwide *Ae. aegypti* eradication program. Within this country, Key West, Florida, is the only community in which an *Ae. aegypti* eradication campaign has been attempted. Because of the dangers of reintroducing the yellow fever virus into the United States and of reintroducing *Ae. aegypti* into areas from which it has been eliminated, the eradication of this species in the United States has recently been given consideration by a number of international, federal, state, and local organizations.

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TABLE 1. NUMBER OF PREMISES SURVEYED AND PERCENT OF INSPECTED PREMISES WITH *AEDES AEGYPTI* DURING SURVEYS CONDUCTED IN WORLD WAR II, 1952, 1956, 1957

State (by east-west tiers)	City	Premises Surveyed							Percent of Premises Found Breeding						
		1942	1943	1944	1945*	1952*	1956	1957	1942	1943	1944	1945*	1952*	1956	1957
Florida	Jacksonville			6,094				410			29.5				30.7
	Key West	?	19,854	8,475	?	?†			11.7	3.8	15.4	21.6	0.0†		
	Miami		134,728	90,251	?	9,576	?†			5.8	7.1	6.1	6.5	1.1†	
	Orlando							200							20.0
	Pensacola							65							29.2
	Tampa				?	105	830	57				13.8	24.7	14.8	52.6
South Carolina	Charleston		35,864	19,515	?	1,979	420	142		2.1	6.2	11.2	1.7	12.6	2.8
	Columbia					347		36					0.6		33.3
Georgia	Atlanta						?	1,542						+1	11.3
	Augusta							116							31.9
	Savannah		22,984	23,179	?	530	1,430			17.2	7.8	8.2	0.0	0.0	
	Thomasville					174	490						50.0	42.2	
Alabama	Birmingham					237							4.6		
	Gadsden						1,260	145						1.1	4.1
	Mobile			25,336	?	1,296	89	526			17.8	16.7	14.7	18.0	20.0
	Montgomery					177							11.3		
	Sheffield							394							0.0
Mississippi	Biloxi					543	248						2.2	0.0	
	Greenwood					187							0.0		
	Gulfport					565		1,125					1.9		0.0
	Hattiesburg							145							5.5
	Jackson					236		864					0.0		0.0
Louisiana	Baton Rouge					516	304	273					20.0	8.2	7.3
	Lake Charles					373	79	734					0.5	2.5	0.0
	Monroe					477		195					1.5		2.1
	New Orleans		44,522	36,798	?	1,304	324	256		5.4	10.5	8.8	6.9	7.4	2.0
	Shreveport					677							0.4		
Texas	Beaumont		29.593			37		253		0.1			0.0		0.0
	Beeville		234	1,681		69				7.7	2.4		0.0		
	Brownsville	?	38,118	17,230	?	406	502	297	19.6	1.1	1.7	1.1	0.7	0.0	0.0
	Corpus Christi	?	34,117	26,863	?	799	419		6.4	0.4	1.2	2.1	0.0	0.0	
	Dallas		325				?†			6.5				+1	
	Del Rio						15†							0.0†	
	Eagle Pass						60†							0.0†	
	El Paso						55†	187						0.0†	0.0
	Galveston		33,054	15,579	?	643	611	629		2.2	1.8	2.5	0.2	0.0	0.0
	Houston	?	115,285	38,650	?	565	582	128	19.1	4.9	3.4	1.2	9.0	3.1	35.9
	Laredo				?	226	715					4.3	0.5	0.0	
	McAllen		11,509	16,238	?	463	100			2.5	2.3	1.0	0.0	1.0	
	San Antonio		7,368	24,285	?	767	398	239		5.9	4.3	6.4	12.0	4.5	13.0
	Texarkana							188							0.0
Mexico	Juarez						?†							0.0†	
	Matamoros						?†							+1	
	Neuvo Laredo						125†							28.0†	
	Piedras Negras						53†							0.0†	
	Villa Acuna						40†							0.0†	
Arizona	Phoenix						906							0.0	
	Tucson						690							0.0	
North Carolina	Charlotte							694							0.0
	Wilmington						597							0.0	
Tennessee	Jackson							337							0.0
	Knoxville							226							0.0
	Memphis						489							3.9	
	Nashville							209							1.0
Arkansas	Pine Bluff					250	409	124					0.0	0.0	0.0
	Little Rock					574							0.9		
Oklahoma	Lawton							485							0.0
	Oklahoma City						1,133	187						0.0	0.0
Virginia	Norfolk				?	1,593		810				4.1	0.0		0.0
	Portsmouth				?	1,990						1.6	0.0		
	Richmond							359							0.0
Kentucky	Louisville						318	301						0.0	0.0
	Paducah							183							0.0
Missouri	Springfield							137							0.0
Kansas	Wichita							63							0.0

* Data from Bradley and Atchley, 1953.

† Data from agencies other than CDC.

‡ *Ae. aegypti* found, but surveys not sufficiently detailed to determine percent premises breeding.

A thorough knowledge of the distribution and density of the species in the United States is essential to a successful *Ae. aegypti* eradication program. Such data are not extensive and there is evidence that the *Ae. aegypti* problem area is a changeable one. During the period of July through September, 1952, personnel of the Communicable Disease Center conducted brief surveys for *Ae. aegypti* in 31 towns and cities in cooperation with State and local health departments (Bradley and Atchley, 1953). In 16 of these cities, distribution and density data had been secured in the course of the *Ae. aegypti* control programs conducted during World War II by the Malaria Control in War Areas program. The authors of the 1952 survey report assembled data to show the location within the United States from which the species had been reported. These data were subsequently used by the United States Public Health Service in delineating the "yellow fever receptive area."

In order to obtain current information on the distribution and density of *Ae. aegypti,* personnel of the Communicable Disease Center conducted surveys for the species during July through September, 1956, in 25 communities, and during 1957 in 38 communities in cooperation with State and local health departments. Personnel from the CDC also cooperated with the Pan American Sanitary Bureau in surveys of 8 communities on the United States-Mexico border. Survey data were also obtained from other investigations in additional communities.

A survey of this type leaves large gaps between areas sampled. In addition, the intensity and extent of the search within a specific community generally has been insufficient to serve as a basis for concluding that negative results mean that *Ae. aegypti* is entirely absent from the area. On the other hand, where several hundred selected premises are examined in a city, the inability to find *Ae. aegypti* does indicate that, if present, the species is rare. Where a comparable search in the same communities in previous years had disclosed breeding of *Ae. aegypti,* the reduction of the species is indicated.

The results of the 1956–1957 surveys, the 1952 survey, and World War II programs are shown in Table I. The states are arranged by latitude and longitude, and the cities are arranged alphabetically within each state. Generally, *Ae. aegypti* was not found in the more northerly cities sampled. Also, note that the species was not found in the port cities of Savannah, Georgia; Biloxi and Gulfport, Mississippi; and Galveston, Corpus Christi, and Brownsville, Texas.

The location of the cities surveyed in 1956 and 1957 is shown in figure 1. In only one city having a survey both years were the results of the two surveys significantly different. This was Lake Charles, Louisiana, found positive in 1956. A survey with negative findings was conducted following extensive clean-up operations after Hurricane Audrey in 1957. The map also shows that negative collections were made along the coast in Georgia, Mississippi, and Texas, while positive collections were made inland in these same states. This was not the case in Florida, Alabama, and South Carolina, where *Ae. aegypti* was found on the coast as well as inland.

The distribution of *Ae. aegypti,* as determined from data of the 1956–1957 surveys, is shown in figure 2. The shaded areas are those from which *Ae. aegypti* has been reported at least once since about 1900. This is a compilation of all reports obtainable, both published and unpublished. The limits were obtained by connecting the extreme counties from which the species has been reported. The area indicated by heavy shading is that in which *Ae. aegypti* was found during the 1956–1957 surveys. The inland limit of this area is a line connecting Charleston, South Carolina; Columbia, South Carolina; Augusta, Georgia; Atlanta, Georgia; Nashville, Tennessee; Memphis, Tennessee; Monroe, Louisiana; Dallas, Texas; and Nuevo Laredo, Tamaulipas, Mexico. This area can

FIGURE 1

Aedes aegypti SURVEYS, 1956-1957

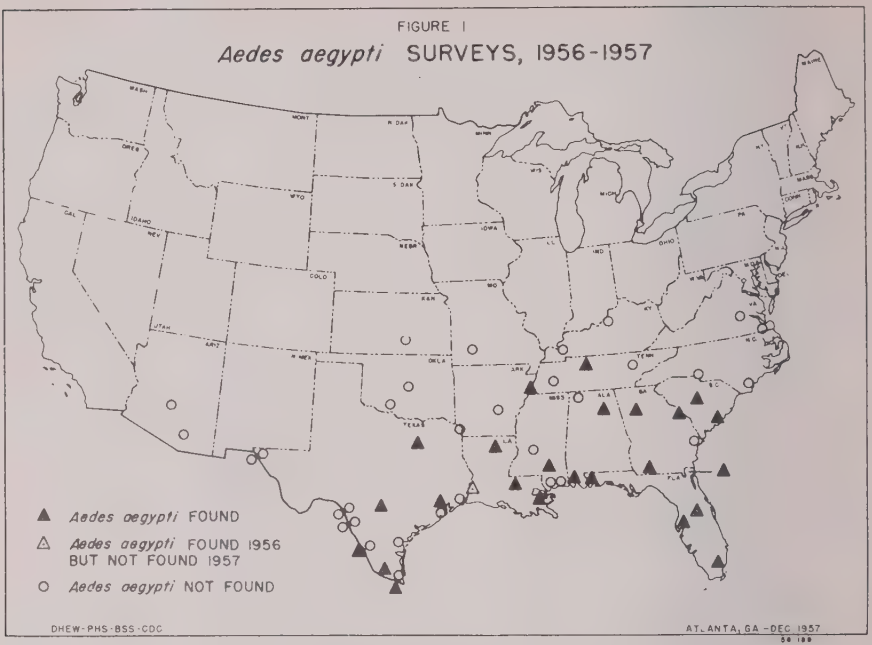
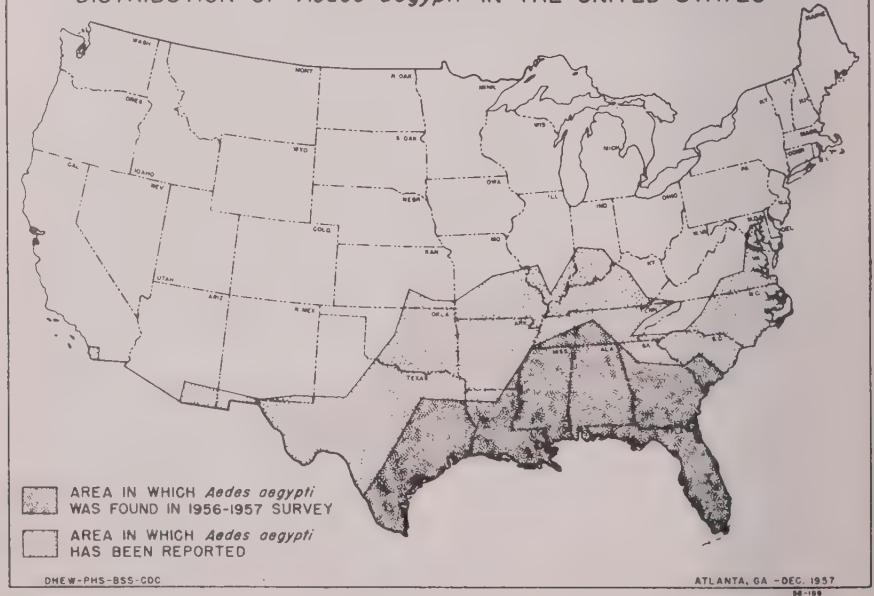

▲ Aedes aegypti FOUND
△ Aedes aegypti FOUND 1956 BUT NOT FOUND 1957
○ Aedes aegypti NOT FOUND
DHEW-PHS-BSS-CDC
ATLANTA, GA -DEC 1957

FIGURE 2

DISTRIBUTION OF *Aedes aegypti* IN THE UNITED STATES


AREA IN WHICH Aedes aegypti WAS FOUND IN 1956-1957 SURVEY
AREA IN WHICH Aedes aegypti HAS BEEN REPORTED
DHEW-PHS-BSS-CDC
ATLANTA, GA -DEC. 1957

be described as that in which *Ae. aegypti* is common. The lightly shaded area is that in which *Ae. aegypti* has been found occasionally but is not common. The environment is unfavorable and the species probably could not exist unless reintroduced repeatedly from areas which are more favorable to it. On the basis of the survey conducted in 1952, it was concluded that the area in which *Ae. aegypti* was a problem had decreased since during World War II. The 1956–1957 data indicate that this trend has continued.

There is evidence that wartime control efforts have built up community awareness of the problem and a recognition of the need for eliminating containers capable of breeding *Ae. aegypti*. The increased use of new and potent household insecticides also has been considered to be an important factor in the reduction. To these should be added the extensive aerial application of agricultural insecticides with accompanying drift and the steady advances in general standards of living. The latter has been characterized by widespread improvement in premises sanitation resulting in a building out of the problem. Simultaneously there has been a greater intolerance by the general population of all noxious vermin.

Notwithstanding the trend toward a reduced area of infestation, the above data indicate that *Ae. aegypti* remains widespread throughout the southern States and occurs abundantly in certain areas. A campaign to eradicate this vector would have to take in an area approximately 1,000 by 300 miles. While this is not as extensive a program as once envisaged, it would still be a large and expensive one.

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Editor's Note:

The paper, "The 1956–1957 Status of *Aedes aegypti* in the United States," printed above is also being published in Spanish in the September number of the *Boletin de la Oficina Sanitaria Panamericana*. The simultaneous publication in English and Spanish was suggested by the Publications Committee of the Pan American Sanitary Bureau through Dr. Fermoselle Bacardi, Scientific Editor for that organization.

OPERATIONAL AND SCIENTIFIC NOTES

AN UNUSUAL SPRAY PUMP. Four cylinders in a radial arrangement, a capacity of ten gallons per minute at pressures up to 500 pounds per square inch, the whole unit housed in an aluminum case no larger than a dishpan (10" in diameter by 7" deep)—these are some of the features which were responsible for the decision to try out one of the new "Ranch Hand" spray pumps for mosquito control in the Kern Mosquito Abatement District.

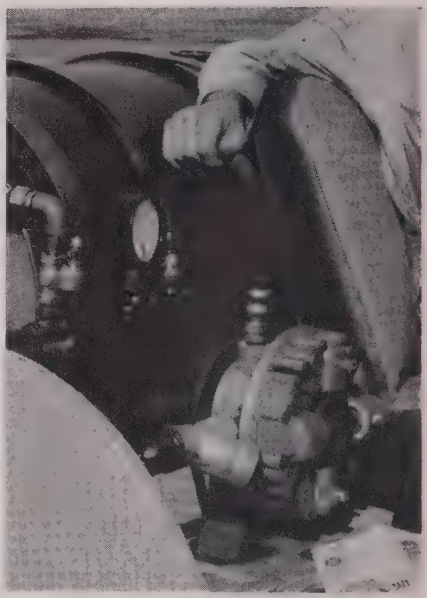
The designer has eliminated connecting rods, as well as heavy crankshaft and many moving parts by substituting for these parts two Scotch yokes through sealed-for-life ball bearings. Each Scotch yoke carries two pistons, one at either end. The stroke is short, only ⅜", and there are four pressure strokes per revolution of the pump shaft, so that operation is very smooth, with little throbbing or vibration. The cylinders are ceramic lined, and the pistons carry double-reverse plunger cups for leak proof performance.

Water suspension sprays can be used, as well as emulsible or oil sprays, and, when the plunger cups finally do need to be replaced, the operation is easily performed by removing the cylinders, which are simply detached, one at a time, from the pump frame, by removing a half dozen machine screws. Stainless steel disc valves and seats appear likely to assure a long and troublefree life.

The small size and weight of the pump make it convenient to mount in a Jeep, alongside the driver's seat, with a chain or vee belt drive to the Jeep power take off. We have used a 50-gallon drum for a supply tank, with a quick-acting shut off located within easy reach of the operator. An overshot pressure regulator and a pressure gauge were added, together with suitable piping to return the overflow to the supply tank for agitation, while the pressure hose was connected to a spray boom and a hand gun, and the machine was ready for trials and operation.

This unit has now been at work in the field for most of the 1958 spray season, and its performance appears to justify the claims of the manufacturer, "The ability to stand up to the rigorous service that will be demanded of it in mosquito control."

The pump has performed most effectively, without problems, even with the wide range of r.p.m.'s encountered on the Jeep power take off under field operating conditions. Its size, operation, and simplicity of maintenance, plus its adaptability to the Jeep power take off has resulted in this becoming the preferred power spray unit among operators of the District.



In addition to the Jeep driven pump, we have installed a similar pump on each of the two Weasels which have been used in the Kern River bottom during this 1958 season. These units are operated by 5 h.p. Wisconsin engines, using V belt drives. Both aqueous emulsions and larviciding oils are commonly handled by these pumps, and these, too, have performed very satisfactorily. The only maintenance requirement has been the replacement of plunger cups once, in each of the Weasel units, where large volumes of oil have been used for larviciding.

The pump was engineered and manufactured by the Livestock Sprayer Manufacturing Company of San Jose, California, and cost approximately $200.00—Arthur F. Geib, Manager Kern Mosquito Abatement District, Bakersfield, Calif.

ASSOCIATION NEWS

Preliminary Note on Program for the 15th Annual Meeting of the AMCA in Salt Lake City, April 12–15, 1959

Following is an abridgment of a notice that Archie Hess, as program chairman, sent to all members of the program committee in August.

A tentative program has been suggested, which contains several innovations which we hope will break up the stale pattern of most professional meetings. One is the "Operations Clinic" which will consist of informal discussions of problem topics by both operations and technical participants; note that *no* speech-making will be allowed! Another is the "Paired Paper" session which, again, we hope will stimulate a lot of informal discussion. The third innovation is the "Special Papers Bull Session." We were prompted to include this by the fact that there are always a number of excellent papers presented which are of great interest to a few individuals but not of general interest to the A.M.C.A. membership. Such papers will be listed on the program, but not presented at the general sessions; instead, on Monday evening authors of these papers will be present with copies of their papers and will be prepared to discuss them with any interested members. We hope this will lead to a lively session of small informal round-table discussions. With the space we shall have available, 6 to 12 separate sessions could be going on concurrently.

Details of the program were not complete at the time this notice was sent around, but the following events, in addition to those mentioned above, will undoubtedly be included: Organ recital at the Mormon Tabernacle; demonstrations of equipment; bus tours around Salt Lake City and to Bingham Canyon and other points of interest; and a train ride across the Great Salt Lake to Promontory Point.

Suggested subjects to be discussed in the "Paired Papers" session include:

1. a. Mosquito control from the wildlife viewpoint.
   b. Wildlife from the mosquito control viewpoint.
2. a. Research from an operator's viewpoint.
   b. Operations from a researcher's viewpoint.
3. a. Toxicology of mosquitocides from the public health viewpoint.
   b. Toxicology of mosquitocides from an operations viewpoint.
4. a. Irrigation mosquitoes from an agricultural viewpoint.
   b. Irrigation mosquitoes from a public health viewpoint.

INFORMATION WANTED

How does *Culex fatigans* (or other *Culex* spp.) breed in septic tanks where the only means of entrance is either by adults entering a vent pipe 20 feet long and 3 inches in diameter, or egg rafts flushed down after being deposited in toilet bowls or other parts of the system? Can they go through more than one generation without blood meals? What is the best control?

Who has some good answers? The inquiries came from J. D. Mabbett, Chief Inspector and Secretary, Department of Health, Brisbane, Australia. Please answer through the Editor, who can give you more background information if needed.

NEWS AND NOTES

AUSTIN W. MORRILL, JR.

MO HIRST HAS DUG UP FROM HIS VOLUMINOUS ARCHIVES A LITTLE POEM ABOUT FLIES which was published in the Port Huron (Mich.) *Times Herald* in 1914, and which starts off:

"Oh listen, I pray,
To the scientist's tune.
A fly swatted now
Saves 1,675,483
In June."

Those of us who were schoolboys in 1914 can well remember being lined up in school and exhorted to swat flies and shown posters put out by the U. S. Department of Agriculture under the impetus of Dr. L. O. Howard's "Swat the Fly" campaign. Some of us even had flyswatters handed to us and we were marched about the school, swatting as we went. (Those were the days when school children were taught Right Thinking and Moral Precepts and we were expected to follow it up with Right Conduct.)

Anyway, thinking about this matter of fundamental training and continuing education reminds us to mention a very good article entitled "In-service Training as Conducted by the San Joaquin Mosquito Abatement District," by LES BRUMBAUGH and HOWARD DUNPHY, which was published in California *Vector Views* for July. Les points out the value of this training not only to increase the individual's work responsibility and service capacity but also to increase his work satisfaction and his ability to further the understanding of the program by the community. For those not already on the *Vector Views* mailing list, it may be secured for the asking.

ROLLIE DORER REPORTS IN THE VIRGINIA MOSQUITO CONTROL ASSOCIATION'S "SKEETER" that they, too, have been working along these lines. On June 13 at the State Department of Health offices, a course was held for school boys who worked as summertime backyard inspectors. "This will be new work for most of these young men," "Skeeter" pointed out, "and they will represent the mosquito control organization in their contacts with the public." "Skeeter" also notes the formation of three new mosquito control districts in the Old Dominion, and a rising tide of interest in another.

THE MILITARY SERVICES HELD THE FIRST OF WHAT MAY BECOME AN ANNUAL COURSE IN MILITARY ENTOMOLOGY AT THE NAVAL MEDICAL CENTER, BETHESDA, MD., during two weeks in July, and of the twenty-six who attended, either as conferees or instructors, or both, fourteen were members of AMCA! The course, which counted as active duty training for the reservists and temporary additional duty for the regular officers, was enthusiastically voted as having been successful in its maiden attempt to bring to active and potential military entomologists information on what is happening in the specialties other than their own. Included were such problems as, "What do we do in a military emergency where mosquito control is essential to success and we have resistance established in the area by prior civil operations?"

SAM HILL ARRIVED IN TOWN DURING THE COURSE, FRESHLY RETIRED FROM HIS MILITARY JOB AT FT. SAM HOUSTON, to take on the task of organizing and directing the office at the National Agricultural Research Center, Beltsville, Maryland, which will deal with research problems needing intensified or priority study throughout the country. Good luck, Mister!

ALTHOUGH IT MAY SEEM EARLY IT'S REALLY NOT A BIT TOO SOON TO BEGIN WORKING ON IT AND THAT'S JUST EXACTLY WHAT ARCHIE HESS IS DOING. Working on the program for the Twelfth Annual Meeting of the Utah Mosquito Abatement Association and the Fifteenth Annual Meeting of the AMCA to be held April 12 through April 15 at Salt Lake City, we mean. It already looks like a real humdinger of a program and it isn't a bit too early for you to start planning to attend. The last day is as good as the first, too, so don't figure on dashing off the middle of the third day and missing the Grand Finale.

ARCHIE HESS HAS A NEW ADDRESS by the way . . . and here it is:

Dr. A. D. Hess
Chief, Encephalitis Section
U.S.P.H.S., P.O. Box 625
Greeley, Colorado

Archie says: "This spring we consolidated the mosquito and encephalitis research activities which had been carried out at Logan and Greeley into one new Encephalitis Section. We will retain the Bakersfield, California, Field Station which is a cooperative endeavor with Bill Reeves. We will move the Chinook, Montana unit to Wenatchee in the Columbia Basin which will enable us to give more attention to the irrigation, mosquito and encephalitis problems which are developing there. We will also have a small field station at Taunton, Massachusetts, doing research on eastern equine encephalitis." Archie *didn't* say who else was going where but as soon as Virg Miles and the others get around to letting us know their new whereabouts, we'll pass it on to you. Any other

changes of address or interesting new activities, among our readers? News and Notes is always anxious to tell your friends . . . so tell *us* all about it!

From I.C.A. and Twin Brother Art Comes Word that Ed Smith is Indeed En Route Home from His Two Years in Indonesia. After attending the three-month training course held in Jamaica, and spending a week or so each in El Salvador, Colombia, Mexico and the District of Columbia, Ed expects to arrive with his wife and their three sons at their home in San Jose by early September. Around the end of the month they'll be heading back for another stint in Indonesia, according to present plans. Ed wrote that the Jamaica course, conducted jointly by I.C.A., U.S.P.H.S. and the Pan American Sanitary Bureau, was both enjoyable and useful and adds that the return to Indonesia is particularly challenging because they have 15 different malaria-carrying anophelines there, with widely different habits and the requirement for different modes of attack. Although the malaria rate in Djakarta eight years ago was 18 percent, the disease has now been wiped out there and in 1957 over 17 million people in Indonesia were protected against it. Transportation is difficult and distances in the archipelago are immense, but Ed feels confident that victory is certain and may even be relatively near.

Another I.C.A.-er We Keep Getting Interesting Notes from Is George Burton who writes this time from Kuantan, Malaya, where he was collecting notes, and perhaps his breath, after a whirlwind tour which included Tulane University, the University of Texas, the pilot filariasis project in the Philippines, the Institute for Medical Research in Kuala Lumpur and way points. George is switching from malaria to filariasis and when he wrote, he expected to take off at the end of July for the Malaria Institute (Filariasis Project) in New Delhi, India. He said he was looking forward to the comparative quiet of New Delhi after discovering that rock and roll had reached Kuantan and specifically had reached his thin-walled Chinese Hotel, full blast. His office will be in New Delhi but his field headquarters will be 1800 miles south at Ernakulam. India apparently has things in common with Texas, all right!

We Saw Capt. Wesley R. Nowell of the U. S. Air Force with his pretty wife and their stairsteps of four charming, tow-headed children at the Nut Tree Inn (California) en route from Germany to McDill Field, Florida. This is McDill Air Force Base to you airmen. We kept wondering why this civilian guy looked so much like an Air Force Captain we knew to be in Germany and then belatedly realized it wasn't our bifocals . . . it *was* the Air Force Captain. The reason they were going to Florida from Germany by way of California is, of course, that Palo Alto is home base for the Nowells. Wes takes his new assignment with the enthusiasm one would expect from a Californian and a Hawaiian, but he feels all life is a worthwhile experience. Seriously, he is mighty happy to have a chance now to work with the Florida AMCA experts and looks forward to the chance to get to the new Research Lab. at Vero Beach . . . as don't we all?

Ralph Barr Sends Us the Request of Dr. Irwin M. Newell of the University of California Who Is Investigating Mite Larvae Parasitic on Mosquitoes. Dr. Newell, who is Associate Professor of Zoology at the Riverside campus, would greatly appreciate receiving specimens of any such mites which mosquito control workers may run across during their survey operations. Dr. Newell writes, "My interest in larvae parasitic on mosquitoes is in conjunction with a research project I am carrying out under the auspices of the National Science Foundation. I am working generally on the problem of mites which have larvae parasitic on insects and other arthropods. Any material you could provide will be greatly appreciated." He adds, "Preservation of the host and all larvae in 70 percent alcohol is the best possible method. The standard information on site of capture, date and collector should be provided as well as the name of the host, if known. Of course, if the host is rare or needed for other purposes, the mites alone would be satisfactory as long as name of host could be provided. Attached mite larvae can usually be removed by means of a sharp needle."

The Dade County Anti-Mosquito District Has Issued a Fine Annual Report for 1957, the cover of which is decorated with an action photo of an employee of theirs, John Winters, who has retired "after twenty years in the marshes." The photo shows him sharpening a brush-cutter in the midst of a clearing job and is an apt reminder of the real fundamental of mosquito control . . . source reduction. This is not lost sight of in the report which covers the very extensive source reduction work of the District, as well as other basic activities, such as larviciding and airplane spraying. This latter was severely hampered by CAA's sudden ruling against the use of single engine aircraft to spray in the vicinities of congested areas. However, they were able to make out with a Beechcraft at a cost of about 10 cents per acre, plus an equivalent amount for materials. House to house inspections covered about one third of the premises in the county, particularly older sections where the percent of premises with mosquito breeding had been found to be the highest. In addition to eliminating the mosquitoes originating in these places, it was felt that

the educational value of the contact by the inspector with the householder was of inestimable value. An incidental finding of interest was that these households yielded some 20,500 old tires in 50 percent of which mosquito breeding was found to be occurring.

ALAMEDA (CALIFORNIA) COUNTY'S TWENTY-SEVENTH ANNUAL REPORT, for 1957, also emphasizes source reduction and training sessions for control personnel, as well as giving brief descriptions of the methods used to combat tree-hole breeding mosquitoes, breeding in catch-basins, and weeds on ditch banks and in small ornamental bodies of water, such as are used in golf courses. In the monthly report for July, CHET ROBINSON again mentions the tree-hole breeders and the control program against them, to the excellence of which he gives credit for the pleasant fact that service calls dropped from 96 the previous year to 53 this year despite the heavier than usual rainfall and higher temperatures. Good going, Chet.

LES BRUMBAUGH reports from the San Joaquin (California) Mosquito Abatement District that he practices what he preached in the article we were mentioning a while ago. Even during the busy months of June and July they found time to work in some 20 to 30 hours of training and instruction. Les reported that despite high temperatures and increased breeding potentialities, their light trap collections showed a 47 percent decrease in mosquitoes during July.

AND GEORGE THOMPSON REPORTS FROM THE JEFFERSON COUNTY (TEXAS) MOSQUITO CONTROL DISTRICT that scattered showers in mid-season caused increases in larvae and adults. Coming largely from salt marsh and fallow rice fields, the adults invaded particularly the cities of Beaumont and Port Arthur. As a control the entire area was dusted twice. *Psorophora* and *Mansonia,* two devils to control, constituted the major portion of George's non-*Culex* species, making a quick rise from obscurity. A particularly interesting observation was made in April, when *Culex salinarius* and *Culex quinquefasciatus* were taken from the same pool.

AND THAT BRINGS US TO WHO'S WHO AND *WHOM* DO YOU THINK WE HAVEN'T TALKED ABOUT YET? TED RALEY, THAT'S WHOM. THE ORIGINATOR OF WHO'S WHO! Well, here's Ted. He was born in San Francisco a year and ten months and six days too late for the great Fire (and earthquake, for you non-San Franciscans). He went to school there or someplace, he doesn't say, until time for college when he went to the University of Redlands, California, and Arizona State College at Tempe. During the great Depression he rose from clerk to owner in a grocery (no small testimony in itself to his inherent ability . . . them was tough days). After a short hitch with the City of Riverside, California, he was with Malaria Control in War Areas of the U.S.P.H.S. until the War was over, when he shifted to civilian control with Sutter-Yuba MAD and then with Consolidated, which he still heads. His office and home are both in Selma, California, near Fresno. He is married and has two daughters and is one of the activest men we ever saw, though he says his hobby is television. He must mean acting in Westerns. He says, too, that he's been a member for ten years but we think he ran out of fingers, because we joined ourselves in 1944 and it seems to us that he was doing some of the Association's leg work, even then.

JOHN BRAWLEY AND BRUCE BROCKWAY APPEARED IN THIS SPACE LAST MONTH BUT WHO'S WHO DIDN'T KNOW THE WHOLE STORY ON EITHER OF THEM SO HERE'S A LITTLE MITE MORE: John has been doing a bang-up job of surveying the mosquito potential for the Navy around the site of one of its largest jet bases, now being built in John's district. Well, John didn't have enough troubles nibbling away at his excellent program, such as increasing irrigation and expanding pasturelands, when the prospect of a sudden doubling of the population with the Navy moving in loomed over him and in the midst of it all he found himself having the distinction of being the first to have parathion resistance show up in his *Aedes nigromaculis.* John tried several combinations of older and less potent insecticides and the combinations worked better than their individual components ever had but they tended to run out quickly so the issue is still in doubt. Maybe John will tell us about it after the season is over and he's had more chance to size things up.

BRUCE modestly didn't tell us the full story on his being "first in the south Pacific in 1942," as mentioned in our little note of last issue. The way he made it sound, he was just in there with the others, and it was the first place he went. But Capt. Ken Knight gave a different version in his history of military entomology, delivered to the Armed Forces course at Bethesda, mentioned earlier. According to Ken, Bruce was THE first mosquito man to get to Guadalcanal and was conducting a major survey well before the arrival of the formally organized malaria control units. The Island was far from secured and the job Bruce did was both important and hazardous. We think this part of mosquito control and military history is valuable and interesting, Bruce, and it ought to be written down before the memory grows faint (could it ever?) and while those who lived the history are vigorously around to tell about it. How about it?

For AMCA members and other readers, we should add that Bruce has recently taken over the chairmanship of the Membership Committee, which Don Johnson felt he had to lay down because of his widespread travels. Pat Nakagawa is co-chairman, and with him Bruce is already starting a big campaign which we know will be a fitting continuation of Don's excellent work.

DICK GERHARDT (DR. RICHARD W., TO HIS FRIENDS) IS OFF GALLIVANTING IN WYOMING so we may well be leaving out the most fascinating parts of his life story but here's what we know about *him:* He was born in Hillsboro, Illinois, and though he continues year after year to look about 23, this event took place way back in July of 1925. He was with the U. S. Army Infantry in the South Pacific from 1943 to 1946 and then came back to get his B.S. at the University of Wyoming in 1949, his M.S. in 1951 and his Ph.D. from the University of California at Davis in 1957. In between he did graduate work at Minnesota, was an instructor at the University of Wyoming, taught in the public schools and then served as Assistant Project Leader for the cooperative CMCA—Calif. Bureau of Vector Control Rice Field Project. In 1954 he became Project Leader and in 1958 he was made Area Representative for the California B.V.C., with headquarters in Sacramento. He is married, has two children, and has a brother, Charles E., in the U.S.P.H.S., stationed at Charlottesville, Va. He is a member of Sigma Xi, the Entomological Society of America, the American Association for the Advancement of Science and, of course, AMCA and CMCA. He listed his hobby as taxonomy some years ago, but he has also let it be whispered around in moments of fun that he is an old ranch hand from the (upper) Rio Grande and we don't know for sure but think he may be in Wyoming getting ready to ride in the Cheyenne Roundup. Hiyo, Richard!

WESLEY NOWELL, whom we mentioned earlier, was born in 1924 in Oakland, California, and moved to Honolulu when he was two, remaining there until he was seventeen, when he returned to California to enter Stanford University. He spent from 1943 to 1946 in the U.S.A.A.F. (that extra A is for Army . . . remember?), ending as a B–29 pilot with the 20th Air Force in the Marianas. He returned to Stanford to finish his B.S. in 1947, his Master's in 1948 and his Ph.D. in 1951. In 1951 he was recalled by the Air Force and transferred to the Medical Service Corps and spent the year with 5th A.F. in Korea and as consultant in Medical Entomology for FEAF in Tokyo. In 1952 he went to Baltimore as Chief of the Medical Entomology Branch of the Office of the Surgeon, Headquarters Air Research and Development Command. From there he went to Germany and is now, as we said before, en route to Florida. His hobby is stamp collecting, so he's had a pretty good chance to do it at first hand. He is a member of Sigma Xi, the E.S.A., the Hawaiian Entomological Society and us.

JAY GRAHAM WAS BORN IN 1922 and if it wasn't in Salt Lake City or County, it jolly well should have been, because he's been mighty closely identified with the place ever since. Although he attended the Universities of Illinois and Purdue, he received both his B.S. and his M.S. from the University of Utah. After two years of high school teaching, he entered mosquito control as an inspector for the Salt Lake City district, became a field supervisor a year later and another year later became Manager of the Salt Lake County Mosquito Abatement District. He has been President of the highly active and enthusiastic Utah Mosquito Control Association, whose meetings are always enjoyable and profitable. And if any of you haven't experienced them, Jay says it's high time you did and there'll never be a better time than this very next year when AMCA meets there with Utah. Jay didn't say what his hobbies are, though we have heard him talk mighty competently about Outdoor Sports of the kind that usually involve a lot of back country walking. We guess that, like most of the rest of the Utah bunch his vocation is hard work and his hobby is good public relations, because he's very good at both.

HARRY STAGE SENDS A GOOD, LONG, INFORMATIVE NOTE, which arrived after our deadline, so we'll have to summarize it briefly. After considerable ground work on his part and that of others, Governor Rosellini of the State of Washington requested the Columbia Basin Inter-Agency Committee to create a sub-committee on mosquito control. This committee is a State-Federal group covering all phases of water development in the seven states drained by the Columbia River. The committee was authorized in March and an organizational meeting was held on 17 June. Roger James, engineer of the Washington State Health Department, was elected chairman, and the committee included LOUIS J. OGDEN (now of Greeley, Colorado?) and entomologists from Montana and Oregon, though none from Washington. Interested spectators were HARRY and WILLIAM E. CLARK, who, as manager of the Adams County Mosquito Abatement District may be considered a member, we guess, since his District is. In a policy statement, the Committee avowed its interest in mosquito control and asserted the existence of severe problems in the Columbia Basin and their mutual obligations to solve them by proper attention to mosquito control in design, operation and maintenance of all water development projects. AMCA members will be happy to see this additional impetus being given toward wider recognition of the importance of the problem which, to us, is so highly important.

DR. JOSEPH M. GINSBURG has returned to the States after a two-years' leave of absence and has resumed his duties at Rutgers University and New Jersey Agricultural Experiment Station as Research Specialist in Entomology, Insecticides.

He has completed an assignment to Israel (1956–1958) on the Point 4 program, as advisor to the Israeli Ministry of Agriculture in toxicology and plant protection problems. He was appointed to this assignment by the Research Foundation of the State University of New York, under the auspices of the United States Operations Mission (USOM), sponsored by the International Cooperation Administration (ICA).

REVIEWS AND ABSTRACTS

HELEN LOUISE DURKEE

THE EPIDEMIOLOGY AND CONTROL OF MALARIA. By George Macdonald. The Oxford University Press, London, New York, and Toronto. 1957. 201 pp. plus Appendices 40 pp. plus index 11 pp. $7.50 (England, 30 s.).—This is a thoroughly practical and useful book by Doctor George Macdonald who is Director of the Ross Institute of Tropical Hygiene and Professor of Tropical Hygiene at the London School of Hygiene and Tropical Medicine. The author discusses in turn the forms of epidemiology; the cycle of transmission; quantitative aspects of transmission, including such factors as reproduction rate, critical level, sporozoite rate, parasite rate, and effect of acquired immunity; equilibrium, e.g. stable and unstable malaria, cyclical changes; epidemics; local features of malaria by geographical regions of the world, including a consideration of the vectors; modern malaria surveys and their interpretation; theory of control; insecticides and their modern use; prophylactic drugs; basic principles of a control program; discussion of malaria eradication and of vector eradication; anopheline susceptibility and resistance to insecticides. In Appendix II, the author describes technics of staining blood films, obtaining spleen indices, capturing anophelines, measuring mosquito survival rates, identifying blood meals, determining susceptibility and resistance, field and laboratory testing of insecticides.

In Appendix I, Professor Macdonald presents a mathematical statement or model of the epidemiology of malaria. His studies have built up a complete picture. Although, as he states, it can not claim to be exact, nevertheless it does give a realistic representation of natural happenings. This the earlier mathematical studies of Ross, Waite, McKendrick, Lotka, and others failed to do. Macdonald was convinced that the logic and the mathematical procedure of the earlier studies was sound but that the premises had been incorrect or incomplete. So he reexamined the fundamental premises and he has succeeded admirably in "building a workmanlike model which, when compared with natural happenings, resembles them sufficiently to provide an acceptable model."

The text of this book is firmly based on the mathematics of Appendix I but is so clearly and concisely written that it does not discourage the non-mathematical reader who applies himself attentively. Here is a book of considerable interest to epidemiologists generally and one for every malariologist to read, to use, and to enjoy.—Paul F. Russell M.D., North Edgecomb, Maine.

THE MOSQUITOES OF WYOMING. By William B. Owen and Richard W. Gerhardt, University of Wyoming. Vol. XXI, No. 3, 70 pp. 1957. This publication is a revised and up-to-date study of the 42 species occurring in the State. Of these 27 are *Aedes*, 5 *Culex*, 4 *Anopheles*, 4 *Culiseta*, and one each of *Mansonia* and *Psorophora*. Taxonomic revisions have changed the names of several species and the authors have dropped *Aedes riparius*, Dyar and Knab, as given in their 1951 lists. Information is given on the distribution, seasonal cycle, breeding habits and relative importance of each species. Keys to adults and fourth instar larvae are included. This is a good-looking booklet, well bound and with well printed pages.—H. H. Stage, Washington State Department of Health.

WANTED: INFORMATION ON *GAMBUSIA*

Mr. Carl J. George is making a special study of the "mosquito fish," *Gambusia affinis* and its survival potential in northern latitudes. He would like to hear from anyone who has data that would help him map its distribution, or who has preserved material that he could study or who has pertinent ecological information. Address: Carl J. George, Harvard Biological Laboratories, 16 Divinity Ave., Cambridge 38, Massachusetts.

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Plant Pest Control Division, Agricultural Research Service, United States Department of Agriculture

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NOTE: Beginning with this issue of Mosquito News, WHO will be the standard abbreviation (in the Bibliography Section) for the World Health Organization, except when the latter is the sponsor of an article, and is used in place of an author's name.

Errata

In volume 17(3):232 of Mosquito News, section on Subjects not Covered by other Headings, under Laird, change 11(1):60–61 to read 11(1):40–62. In volume 18(1):45, section on Taxonomy, under Darsie, change 50(5) to read 50(6).

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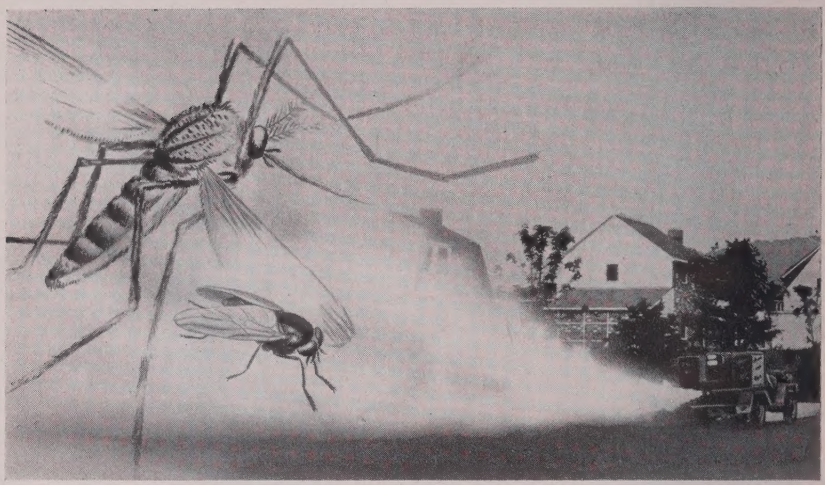

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